CHAPTER 4

Affected Environment

4. AFFECTED ENVIRONMENT

In Chapter 4, the affected environment descriptions provide the context for understanding the environmental consequences described in Chapter 5. They serve as a baseline from which any environmental changes brought about by implementing the proposed action can be evaluated; the baseline conditions are the currently existing conditions. The affected environments at Los Alamos National Laboratory, Sandia National Laboratories/New Mexico, Nevada Test Site, and Argonne National Laboratory-West are described for the following impact areas: land resources, site infrastructure, air quality, noise, geology and soils, water resources, ecological resources, cultural and paleontological resources, socioeconomics, environmental justice, existing human health risk, and waste management.

4.1 APPROACH TO DEFINING THE AFFECTED ENVIRONMENT

In accordance with the Council on Environmental Quality guidance under National Environmental Policy Act (NEPA) regulations (40 CFR 1500 through 1508) for preparing an environmental impact statement (EIS), the affected environment is "Interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." The affected environment descriptions presented in this chapter provide the context for understanding the environmental consequences described in Chapter 5. They serve as a baseline from which any environmental changes brought about by implementing the proposed action can be evaluated; the baseline conditions are the currently existing conditions.

For this *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, (*TA-18 Relocation EIS*) the candidate sites are Los Alamos National Laboratory (LANL); Sandia National Laboratories/New Mexico (SNL/NM), located within the boundaries of Kirtland Air Force Base (KAFB); Nevada Test Site (NTS); and Argonne National Laboratory-West (ANL-W), located within the boundaries of the Idaho National Engineering and Environmental Laboratory (INEEL). The affected environment is described for the candidate sites for the following resource areas: land resources, site infrastructure, air quality, noise, geology and soils, water resources, ecological resources, cultural and paleontological resources, socioeconomics, environmental justice, existing human health risk, and waste management. For each U.S. Department of Energy (DOE) site, each resource area is described first for the site as a whole and then for the candidate sites, as appropriate. The level of detail varies depending on the potential for impacts resulting from each relocation alternative.

The Solution High-Energy Burst Assembly (SHEBA) could be relocated from TA-18 to a new building constructed at LANL's TA-39, and other security Category III/IV activities could be relocated to TA-55. LANL's TA-18 and TA-55 affected environments are presented in this chapter. LANL's TA-39 affected environment is presented separately in Chapter 5, Section 5.6.2, in association with the separate SHEBA and other security Category III/IV relocation analysis.

The following site-specific and recent project-specific documents were important sources of information in describing the existing environment at each of the proposed relocation sites. Numerous other sources of site- and resource-related data were also used in the preparation of this chapter and are cited as appropriate.

- *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (LANL SWEIS)* (DOE 1999b)

- *Final Site-Wide Environmental Impact Statement for Sandia National Laboratories/New Mexico (SNL/NM SWEIS)* (DOE 1999d)

- *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada (NTS SWEIS)* (DOE 1996d)

- *Idaho High-Level Waste and Facilities Disposition Draft Environmental Impact Statement* (DOE 1999h)

- *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE 2000d)

- *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility (NI PEIS)* (DOE 2000j)

DOE evaluated the environmental impacts of the proposed action within defined regions of influence at each of the candidate sites and along potential transportation routes. The regions of influence are specific to the type of effect evaluated, and encompass geographic areas within which any significant impact would be expected to occur. For example, human health risks to the general public from exposure to airborne contaminant emissions were assessed for an area within an 80-kilometer (50-mile) radius of the proposed facilities. The human health risks of shipping materials between sites were evaluated for populations living along roadways linking the DOE sites. Economic effects such as job and income changes were evaluated within a socioeconomic region of influence that include the county in which the site is located and nearby counties in which substantial portions of the site's workforce reside. Brief descriptions of the regions of influence are given in **Table 4–1**. More detailed descriptions of the regions of influence and the methods used to evaluate impacts are presented in Appendix F.

Table 4–1 General Regions of Influence for the Affected Environment

Environmental Resources	*Region of Influence*
Land resources	The site and the areas immediately adjacent to the site
Site infrastructure	The site
Air quality	The site, nearby offsite areas within local air quality control regions, where significant air quality impacts may occur, and Class I areas within 100 kilometers
Noise	The site, nearby offsite areas, access routes to the sites, and the transportation corridors
Geology and soils	Geologic and soil resources within the site and nearby offsite areas
Water resources	Onsite and adjacent surface water bodies and groundwater
Ecological resources	The site and adjacent areas
Cultural and paleontological resources	The area within the site and adjacent to the site boundary
Socioeconomics	The counties where approximately 90 percent of site employees reside
Environmental justice	The minority and low-income populations within 80 kilometers (50 miles) of the site, and along the transportation corridors between the sites
Existing human health risk	The site, offsite areas within 80 kilometers (50 miles) of the site, and the transportation corridors between the sites where worker and general population radiation, radionuclide, and hazardous chemical exposures may occur
Waste management	The site

At each of the candidate sites, baseline conditions for each environmental resource area were determined for ongoing operations from information provided in previous environmental studies, relevant laws and regulations, and other Government reports and databases. More detailed information of the affected

environment at the candidate sites can be found in annual site environmental reports and site NEPA documents.

4.2 LOS ALAMOS NATIONAL LABORATORY

LANL is located on 11,272 hectares (27,832 acres) of land in north central New Mexico (**Figure 4–1**). The site is located 97 kilometers (60 miles) north-northeast of Albuquerque, 40 kilometers (25 miles) northwest of Santa Fe, and 32 kilometers (20 miles) southwest of Española. LANL is owned by the Federal Government and administered by DOE's National Nuclear Security Administration (NNSA). It is operated by the University of California under contract to DOE. Portions of LANL are located in Los Alamos and Santa Fe Counties. DOE's principal missions are national security, energy resources, environmental quality, and science and each of these missions is supported by activities conducted at LANL.

LANL is divided into 49 separate technical areas (TAs) with location and spacing that reflect the site's historical development patterns, regional topography, and functional relationships (**Figure 4–2**). While the number of structures changes somewhat with time (e.g., as a result of the Cerro Grande Fire; see Section 4.2.1.1), there are 944 permanent structures; 512 temporary structures; and 806 miscellaneous buildings with approximately 465,000 square meters (5,000,000 square feet) that could be occupied. In addition to onsite office space, 19,833 square meters (213,262 square feet) of space is leased within the Los Alamos town site and White Rock community (DOE 1999b).

TA-18 is the current location of the Los Alamos Critical Experiments Facility. Activities within this TA study both static and dynamic behavior of critical assemblies of nuclear materials. In addition, this facility provides the capability to perform hands-on training and experiments with SNM in various configurations below critical (DOE 1999b). Special nuclear materials (SNM) are used to support a wide variety of activities for stockpile management, stockpile stewardship, emergency response, nonproliferation, and safeguards.

TA-55 is one of the sites proposed for the relocation of missions currently performed at TA-18. TA-55 is located in the west-central portion of LANL. TA-55 facilities provide research and applications in chemical and metallurgical processes for recovering, purifying, and converting plutonium and other actinides into many compounds and forms, as well as research into material properties and fabrication of parts for research and stockpile applications. Additional activities include the means to safely and securely ship, receive, handle, and store nuclear materials, as well as manage the waste and residue produced by TA-55 operations (DOE 1999b). Unless otherwise referenced, the following descriptions of the affected environment at LANL, TA-18, and TA-55 are based all or in part on information provided in the *LANL SWEIS* (DOE 1999b), which is incorporated by reference.

TA-39 is a site proposed for the relocation of SHEBA activities currently performed at TA-18. Specific characteristics of the affected environment at TA-39 are provided in Section 5.6.

4.2.1 Land Resources

4.2.1.1 Land Use

Land use in this region is linked to the economy of northern New Mexico, which depends heavily on tourism, recreation (e.g., skiing, fishing), agriculture, and the state and Federal Governments for its economic base. Area communities are generally small, such as the Los Alamos town site with under 12,000 residents, and primarily support urban uses including residential, commercial, light industrial, and recreational facilities. The region also includes Native American communities; lands of the Pueblo of San Ildefonso share LANL's eastern border, and a number of other pueblos are clustered nearby. Major governmental bodies that serve

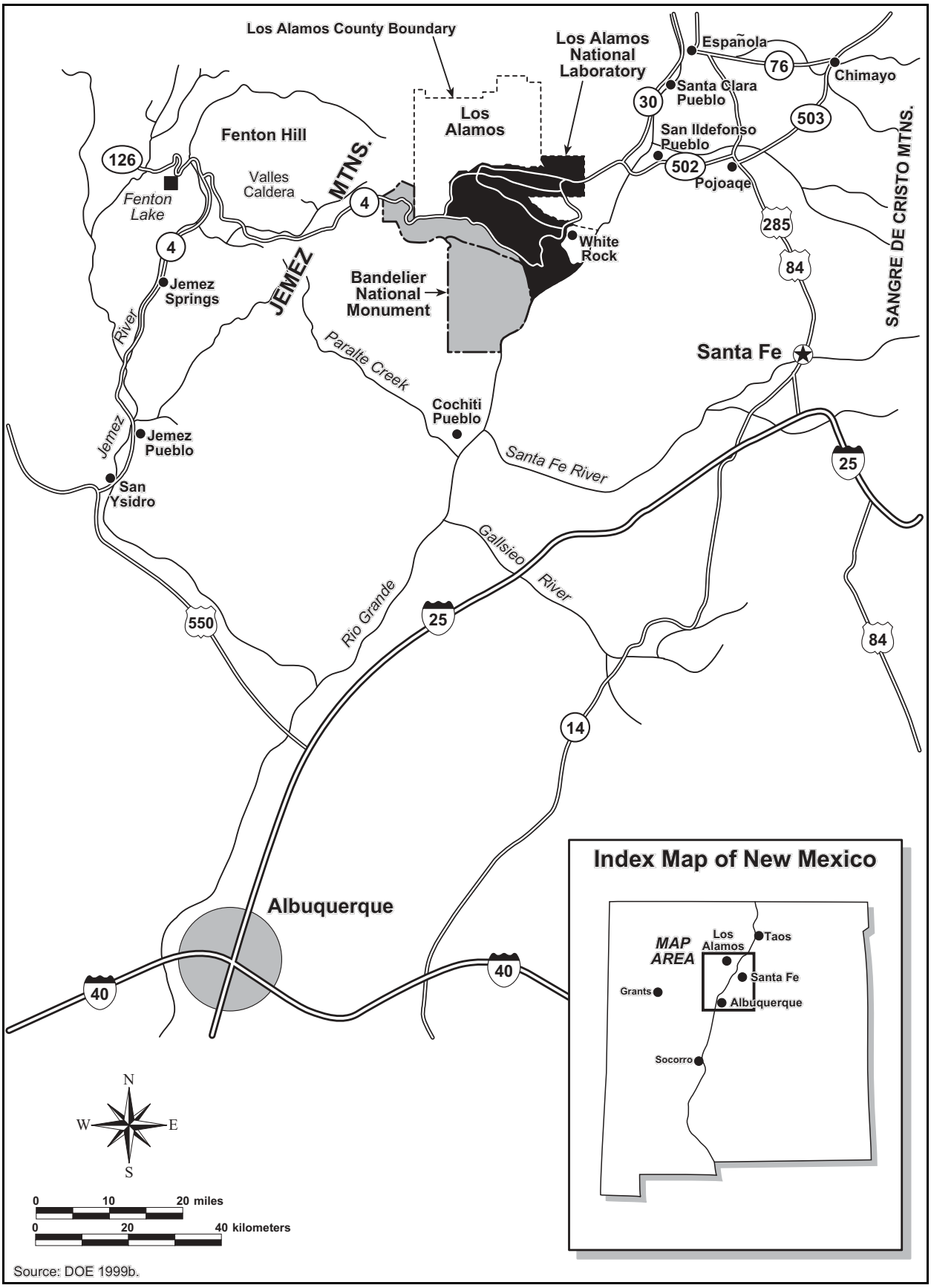


Figure 4–1 Location of LANL

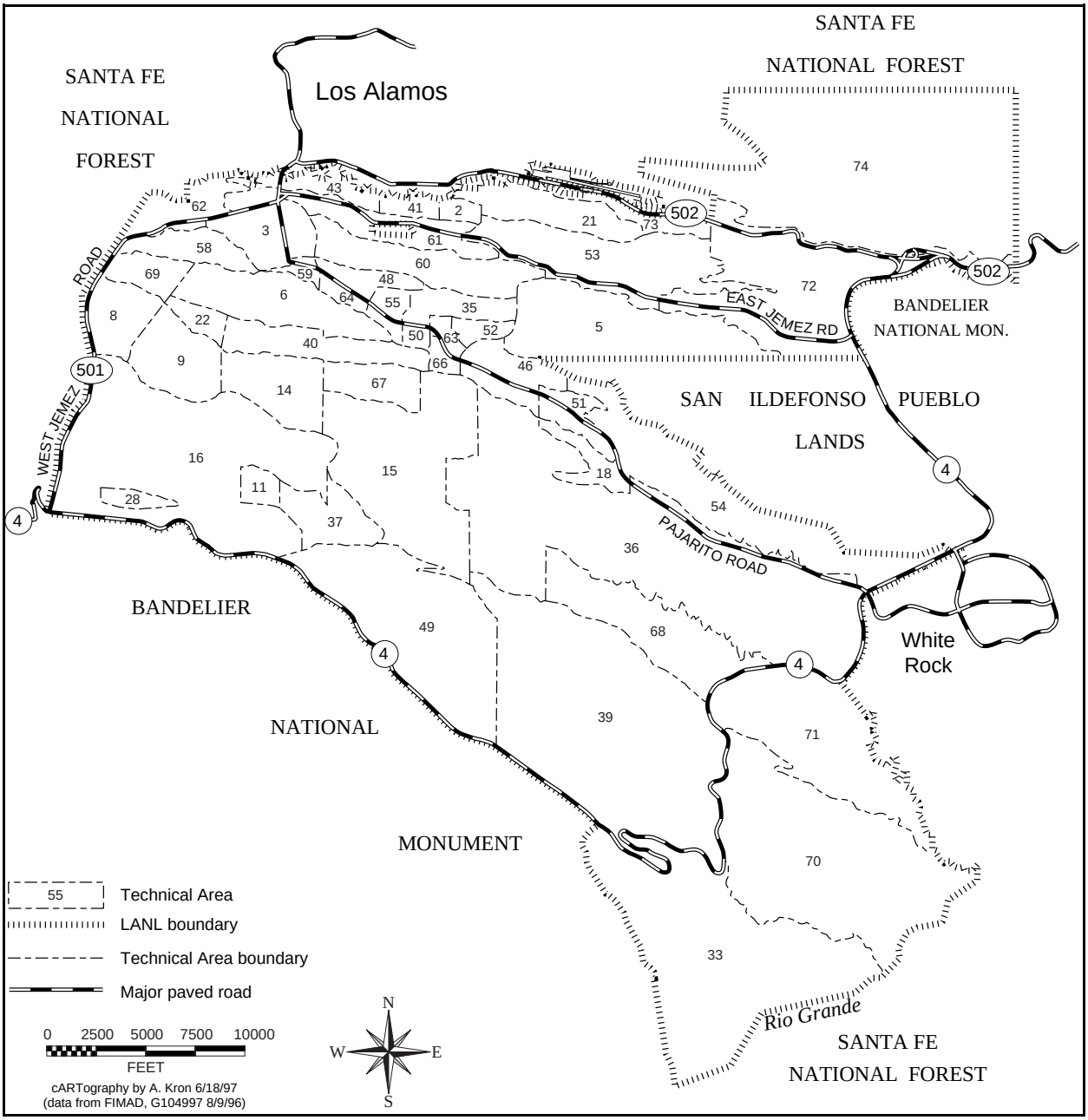
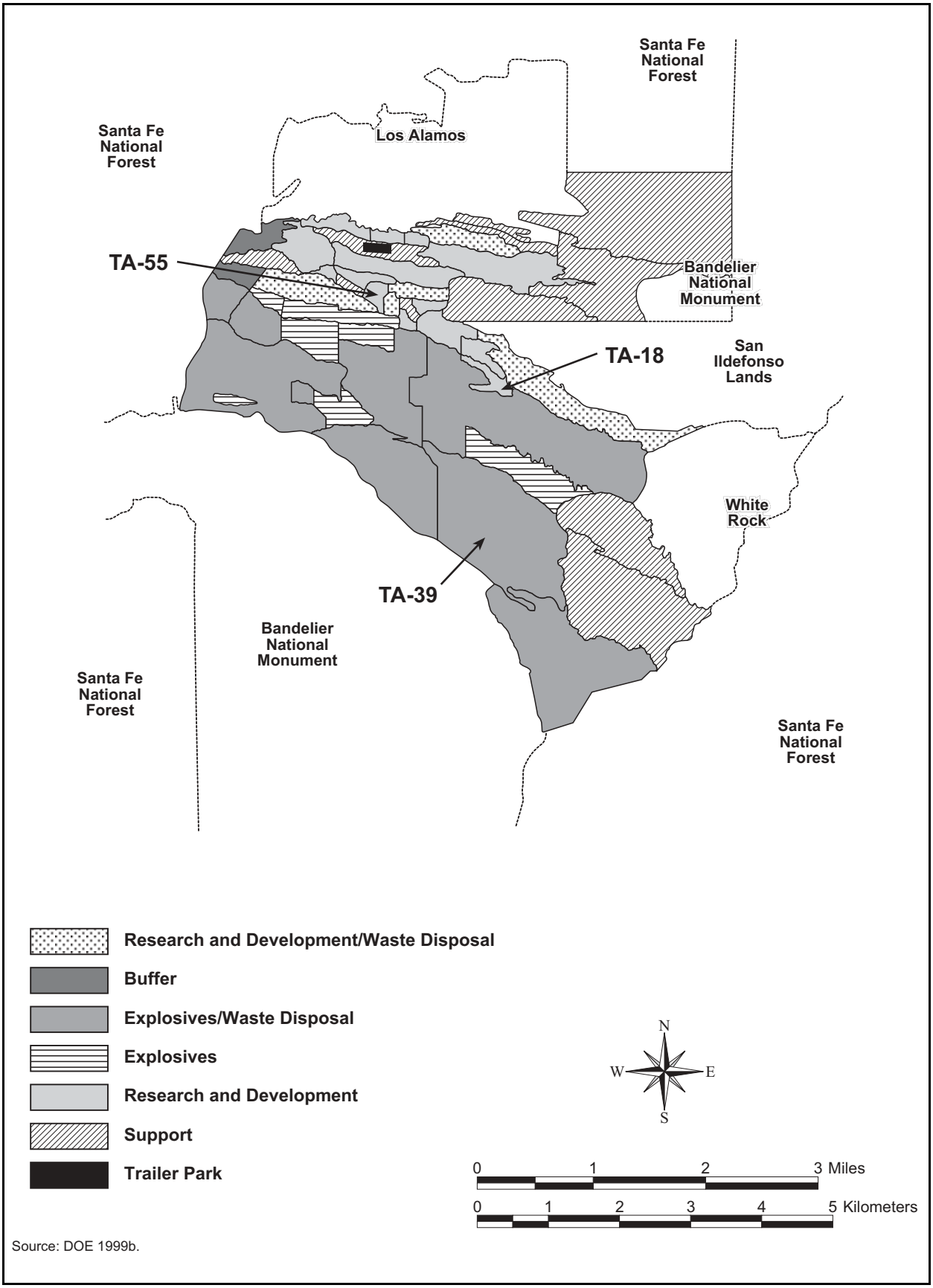


Figure 4–2 Technical Areas of LANL

as land stewards and determine land uses within Los Alamos and Sante Fe counties include the county governments, DOE, the U.S. Forest Service, the National Park Service, the State of New Mexico, the U.S. Bureau of Land Management, and several Native American pueblos. Bandelier National Monument and Santa Fe National Forest border LANL primarily to the southwest and northwest, respectively; however, small portions of each also border the site to the northeast (see **Figure 4–3**).

Land use characterization at LANL is based on the most hazardous activities in each TA and is organized into six categories.



Source: DOE 1999b.

Figure 4–3 Land Use at LANL

Support—Includes TAs with only support facilities that do not perform research and development activities and are generally free from chemical, radiological, or explosive hazards; also includes undeveloped TAs other than those that serve as buffers.

Research and Development—Includes TAs that perform research and development activities with associated chemical and radiological hazards, but that are generally free of explosives hazards; does not include waste disposal sites.

Research and Development/Waste Disposal—The remaining research and development areas (i.e., those areas that are generally free of explosives hazards and have existing waste disposal sites).

Explosives—Includes TAs where explosives are tested or stored, but does not include waste disposal sites.

Explosives/Waste Disposal—The remaining sites where explosives are tested or stored (i.e., those with existing waste disposal sites).

Buffer—Land identified in each of the usage types described above also may serve as a buffer area. This last land use category therefore includes areas that only serve as buffers for the safety or security of other TAs, usually explosives areas.

LANL is divided into TAs that are used for building sites, experimental areas, and waste disposal locations. However, those uses account for only a small part of the total land area of the site. In fact, only 5 percent of the site is estimated to be unavailable to most wildlife (because of security fencing). Most of the site is undeveloped to provide security, safety, and expansion possibilities for future mission requirements. There are no agricultural activities present at LANL, nor are there any prime farmlands. In 1977, DOE designated LANL as a National Environmental Research Park, which is used by the national scientific community as an outdoor laboratory to study the impacts of human activities on pinyon-juniper woodland ecosystems (DOE 1996f). In 1999, the White Rock Canyon Wildlife Reserve was dedicated. It is about 405 hectares (1,000 acres) in size and is located on the southeast perimeter of LANL. The reserve is managed jointly by DOE and the National Park Service for its significant ecological and cultural resources and research potential (LANL 2000f).

Beginning on May 5, 2000, a wildfire, know as the Cerro Grande Fire, burned across the Los Alamos area. By the time the fire was fully contained on June 6, it had burned a total of 17,462 hectares (43,150 acres), of which 3,061 hectares (7,650 acres) were within the boundaries of LANL. In general, impacts of the fire on land use in the region should be temporary. For example, access and use of certain recreation areas and trails will be restricted over the next two to three years within at least part of LANL and the surrounding forestlands. Within LANL, 45 structures (trailers, transportable, and storage units) were totally destroyed and 67 were damaged. The fire also affected land use in the Los Alamos town site, where about 230 housing units were totally destroyed (LANL 2000b, DOE 2000g).

The Los Alamos County Comprehensive Plan, which established land planning issues and objectives, addresses private and county lands comprising 3,488 hectares (8,613 acres). Twenty-nine percent of this land is located within the Los Alamos town site and 26 percent is located in the community of White Rock. The remaining 45 percent of the land is undeveloped and is used for recreational activities and open space. LANL is autonomous from a planning perspective and, therefore, is not addressed in the county plan. Land-use designations in the Santa Fe County Plan are based on groundwater protection goals. Therefore, this plan designates LANL as "Agricultural and Residential," although, as noted above, there are no agricultural activities on the site, nor are there any residential uses within LANL boundaries (DOE 1996f).

TA-18 is located within the Research and Development land use category (Figure 4–3). Facilities at TA-18 are located on a 53-hectare (131-acre) site that is situated 4.8 kilometers (3 miles) from the nearest residential area, White Rock. Approximately 20 percent of the site has been developed. Site facilities are located in a canyon near the confluence of Pajarito Canyon and Threemile Canyon. TA-18 structures include a main building, three outlying remote-controlled critical assembly buildings known as Critical Assembly Storage Areas or CASAs, and several smaller laboratory, nuclear material storage, and support buildings. A security fence to aid in physical safeguarding of SNM bounds the entire site (see Figure 3–1).

TA-55 is also located within the Research and Development land use category (see Figure 4–3). Facilities at TA-55 are located on a 16-hectare (40-acre) site that is situated 1.8 kilometers (1.1 miles) south of the city of Los Alamos. Forty-three percent of the site has been developed. The main complex has five connected buildings; the Nuclear Materials Storage Facility is separate from the main complex but shares an underground transfer tunnel. A security fence to aid in physical safeguarding of SNM bounds the entire site (see Figure 3–1).

The Cerro Grande Fire at times threatened structures at TA-18 and TA-55 (LANL 2000b). However, no permanent buildings were damaged or destroyed.

4.2.1.2 Visual Resources

The topography in northern New Mexico is rugged, especially in the vicinity of LANL. Mesa tops are cut by deep canyons, creating sharp angles in the land form. In some cases, slopes are nearly vertical. Often, little vegetation grows on these steep slopes, exposing the geology, with contrasting horizontal planes varying from fairly bright reddish orange to almost white in color. A variety of vegetation occurs in the region, the density of vegetation and height of which may change over time and can affect the visibility of an area within the LANL viewshed. Undeveloped lands within LANL have a Bureau of Land Management Visual Resource Contrast rating of Class II and III. Management activities within these classes may be seen but should not dominate the review.

For security reasons, much of the development within LANL has occurred out of the public's view. Passing motorists or nearby residents can see only a small fraction of what is actually there. Prior to the Cerro Grande Fire, the view of most LANL property from many stretches of area roadways was that of woodlands and brushy areas. Views from various locations in Los Alamos County and its immediate surroundings have been altered by the Cerro Grande Fire, which burned over 17,462 hectares (43,150 acres) of the area in the summer of 2000. Although the visual environment is still diverse, interesting, and panoramic, portions of the visual landscape are dramatically stark. Rocky outcrops forming the mountains are now visible through the burned forest areas. The eastern slopes of the Jemez Mountains, instead of presenting a relatively uniform view of dense green forest, are now a mosaic of burned and unburned areas. Grasses and shrubs initially will replace forest stands and will contribute to the visual contrast between the burned and unburned areas for many years. Local effects include reduced visual appeal of trails and recreation areas (DOE 2000g).

The most visible developments at LANL are a limited number of very tall structures; facilities at relatively high, exposed locations; or those beside well-traveled, publicly accessible roads within the core part of LANL, the TA-3 area. Developed areas within LANL are consistent with a Class IV Visual Resource Contrast rating, in which management activities dominate the view and are the focus of viewer attention.

At lower elevations, at a distance of several miles away from LANL, the facility is primarily distinguishable in the daytime by views of its water storage towers, emission stacks, and occasional glimpses of older buildings that are very austere and industrial in appearance. Similarly, the Los Alamos town site appears mostly residential in character, with the water storage towers very visible against the backdrop of the Jemez

Mountains. At elevations above LANL, along the upper reaches of the Pajarito Plateau rim, the view of LANL is primarily of scattered austere buildings and the nested several-storied buildings of TA-3. Similarly, the residential character of the Los Alamos town site is predominately visible from higher elevation viewpoints. At night, the lights of LANL, the Los Alamos town site, and White Rock are directly visible from various locations across the viewshed as far away as the towns of Española and Santa Fe.

TA-18 is located at the bottom of a canyon at the confluence of Pajarito Canyon and Threemile Canyon. Since the surrounding canyon walls rise approximately 61 meters (200 feet) above the site, TA-18 is not visible from any offsite location, including White Rock, which is located 4.8 kilometers (3 miles) to the east. Developed portions of TA-18 would have a Class IV Visual Resource Contrast rating.

TA-55 is located on a mesa about 1.6 kilometers (1 mile) southeast of TA-3. While not visible from lower elevations, TA-55 is visible from higher elevations to the west along the upper reaches of the Pajarito Plateau rim, from where it appears as one of several scattered built-up areas among the heavily forested areas of the site. As is the case for TA-18, developed portions of TA-55 would have a Class IV Visual Resource Contrast rating.

4.2.2 Site Infrastructure

Site infrastructure characteristics for LANL are summarized in **Table 4–2**.

Table 4–2 LANL Sitewide Infrastructure Characteristics

Resource	*Site Usage*	*Site Capacity*
Transportation		
Roads (kilometers)	130 [a]	Not applicable
Railroads (kilometers)	0	Not applicable
Electricity [b]		
Energy (megawatt-hours per year)	475,868	937,000
Peak load (megawatts)	83	107
Fuel		
Natural gas (cubic meters per year)	70,000,000 [c]	229,400,000 [d]
Liquid fuels (liters per year)	Negligible	Not limited
Coal (metric tons per year)	0	0
Water (liters per year)	1,715,000,000	2,050,000,000 [e]

[a] Includes paved roads and paved parking areas only.
[b] Usage and capacity values are for the entire Los Alamos Power Pool.
[c] Usage value for LANL plus baseline usage for other Los Alamos County users.
[d] Entire service area capacity which includes LANL and other Los Alamos area users.
[e] Equivalent to 30 percent of the water right allocation from the main aquifer.
Source: DOE 1999b, DOE 1999f, LANL 2000e.

4.2.2.1 Ground Transportation

About 130 kilometers (80 miles) of paved roads and parking surface have been developed on LANL (see Table 4–2). There is no railway service connection at the site. Local and linking regional transportation systems, including roadways, are detailed in Section 4.2.9.4.

4.2.2.2 Electricity

Electrical service to LANL is supplied through a cooperative arrangement with Los Alamos County, known as the Los Alamos Power Pool, which was established in 1985. Electric power is supplied to the pool

through two existing regional 115-kilovolt electric power lines. The first line (the Norton-Los Alamos line) is administered by DOE and originates from the Norton Substation near White Rock, and the second line (the Reeves Line) is owned by the Public Service Company of New Mexico and originates from the Bernalillo-Algodones Substation. Both substations are owned by the Public Service Company of New Mexico. DOE also operates a gas-fired steam/power plant at TA-3 that is used on an as-needed basis and maintains various low-voltage transformers at LANL facilities and approximately 55 kilometers (34 miles) of 13.8-kilovolt distribution lines (DOE 2000b).

Pool resources currently provide a contractually limited 73 megawatts during winter months to about 95 megawatts during the spring and early summer months from a number of hydroelectric, coal, and natural gas power generators throughout the western United States (LANL 2000e). Onsite electric generating capacity for the pool is limited to the existing TA-3 steam/power plant, which has an operating capacity of 12 megawatts in the summer and 15 megawatts in the winter. Historically, offsite power system failures have disrupted operations in LANL facilities. Therefore, all facilities that require safe shutdown capability for power outages are equipped with emergency generators to assure these needs are met, including nuclear facilities such as TA-55 and the Chemistry and Metallurgy Research Building. The TA-3 steam/power plant currently provides the additional electricity needed to meet peak load demands exceeding the allowable supply. The TA-3 steam/power plant and the majority of LANL's electrical distribution network are past or nearing the end of their design life and require replacement or upgrading. To improve overall supply reliability, construction and operation of a new 115-kilovolt power line is planned that would originate at the existing Public Service Company of New Mexico-owned Norton Substation and terminate at a proposed DOE-administered West Technical Area Substation (DOE 2000b).

Electricity consumption and peak demands by LANL have historically fluctuated largely as a result of power demand by the Los Alamos Neutron Science Center. Electric power availability from the pool (based on a summer peak load capacity of 107 megawatts) is 937,000 megawatt-hours per year (DOE 1999f). In fiscal year 1999 (FY99), LANL used 369,321 megawatt-hours of electricity which was an eight-year low. Other Los Alamos County users consumed an additional 106,547 megawatt-hours. The FY99 peak load usage was about 68 megawatts for LANL and about 14 megawatts for the rest of the county (LANL 2000e). The estimated peak load capacity is 107 megawatts during the summer peak season (see Table 4–2) (DOE 1999f). In FY 2000, TA-55 used 14,158 megawatt-hours of electricity. Electric power usage at TA-18 is estimated to consistently average 2,836 megawatt-hours annually (LANL 2001a).

4.2.2.3 Fuel

Natural gas is the primary fuel used in Los Alamos County and at LANL. The natural gas system includes a high-pressure main and distribution system to Los Alamos County and pressure-reducing stations at LANL buildings. In August 1999, DOE sold the 209-kilometer-long (130-mile) main gas supply line and associated metering stations to Los Alamos and vicinity to Public Service Company of New Mexico (LANL 2000e). The county and LANL both have delivery points where gas is monitored and measured. LANL burns natural gas to generate steam to heat buildings. The natural gas delivery system servicing the Los Alamos area has a contractually-limited capacity of about 229 million cubic meters (8.07 billion cubic feet) per year (DOE 1999f). In FY99, LANL used approximately 40.5 million cubic meters (1.43 billion cubic feet) of natural gas (see Table 4–2). Some 90 percent of the natural gas used at LANL is for heating and the remainder for electricity generation to meet peak demands (LANL 2000e). The rest of the service area including Los Alamos County is estimated to use an average of 29.5 million cubic meters (1.04 billion cubic feet) of natural gas annually (DOE 1999f). Relatively small quantities of fuel oil are also stored at LANL as a backup fuel source and use is therefore negligible (DOE 1996f). TA-18 and TA-55 use natural gas to fire boilers and for other facility uses. Natural gas usage at TA-18 is estimated to be about 200 cubic meters

(7,000 cubic feet) per year. TA-55 is estimated to use approximately 1.3 million cubic meters (45 million cubic feet) of natural gas annually (LANL 2001a).

4.2.2.4 Water

The Los Alamos potable water production system consists of 14 deep wells, 246 kilometers (153 miles) of main distribution lines, pump stations, storage tanks, and nine chlorination stations. On September 8, 1998, DOE transferred operation of the system from the LANL to Los Alamos County under a lease agreement. Under this agreement, LANL retained responsibility for operating the distribution system within its boundaries, whereas the county assumed full responsibility for operating the water system, including ensuring compliance with Federal and state drinking water regulations (LANL 2000f). The system supplies potable water to all of the county, LANL, and Bandelier National Monument. DOE's rights to withdraw an equivalent of about 6,830 million liters (1,806 million gallons) of water per year from the main aquifer and its right to purchase a water allocation from the San Juan-Chama Transmountain Diversion Project were included in the lease agreement. DOE plans to ultimately convey 70 percent of the water rights to the county (including the entire San Juan-Chama right) and lease the remainder to the county (LANL 2000e). Per the current lease agreement, LANL would retain the right to purchase the leased percentage with provision to purchase water in excess of the 30 percent (equivalent to about 2.05 billion liters [542 million gallons] annually) if available (DOE 1999f). Before transfer of the Los Alamos water supply system in October 1998, LANL's water use was estimated by subtracting the county's metered water use from total well production that resulted in counting other users such as Bandelier National Monument and system losses in the LANL water use total.

In 1999, LANL used approximately 1.71 billion liters (453 million gallons) of water (LANL 2000e) (see Table 4–2). Potable water is obtained from deep wells located in three well fields (Gauje, Otowi, and Pajarito). Nonpotable water is also supplied to the TA-16 steam plant from the Water Canyon Gallery. This system consists of about 1.6 kilometers (1 mile) of water line and a catchment basin improvement to a spring. TA-18 currently uses about 14.65 million liters (3.87 million gallons) of water annually.

4.2.3 Air Quality

Los Alamos has a semiarid, temperate mountain climate. This climate is characterized by seasonable, variable rainfall with precipitation ranging from 25 to 51 centimeters (10 to 20 inches) per year. The climate of the Los Alamos town site is not as arid (dry) as that part near the Rio Grande, which is arid continental. Meteorological conditions within Los Alamos are influenced by the elevation of the Pajarito Plateau. Climatological averages for atmospheric variables such as temperature, pressure, winds, and precipitation presented are based on observations made at the official Los Alamos meteorological weather station from 1961 to 1990. Normal (30-year mean) minimum and maximum temperatures for the community of Los Alamos range from a mean low of -8.1 °C (17.4 °F) in January to a mean high of 27 °C (80.6 °F) in July. Normal (30-year mean) minimum and maximum temperatures for the community of White Rock range from a mean low of -9.7 °C (14.6 °F) in January to a mean high of 29.8 °C (85.6 °F) in July. Temperatures in Los Alamos vary with altitude, averaging 3 °C (5 °F) higher in and near the Rio Grande Valley, which is 1,981 meters (6,500 feet) above sea level, and 3 to 5.5 °C (5 to 10 °F) lower in the Jemez Mountains, which are 2,600 to 3,050 meters (8,500 to 10,000 feet) above sea level. Los Alamos town site temperatures have dropped as low as -28 °C (-18 °F) and have reached as high as 35 °C (95 °F). The normal annual precipitation for Los Alamos is approximately 48 centimeters (19 inches). Annual precipitation rates within the county decline toward the Rio Grande Valley, with the normal precipitation for White Rock at approximately 34 centimeters (14 inches). The Jemez Mountains receive over 64 centimeters (25 inches) of precipitation annually. The lowest recorded annual precipitation in Los Alamos town site was 17 centimeters (7 inches) and the highest was 100 centimeters (39 inches).

Thirty-six percent of the annual precipitation for Los Alamos County and LANL results from thundershowers that occur in July and August. Winter precipitation falls primarily as snow. Average annual snowfall is approximately 150 centimeters (59 inches), but can vary considerably from year to year. Annual snowfall ranges from a minimum of 24 centimeters (9 inches) to a maximum of 389 centimeters (153 inches).

Los Alamos County winds average 3 meters per second (7 miles per hour). Wind speeds vary throughout the year, with the lowest wind speeds occurring in December and January. The highest winds occur in the spring (March through June), due to intense storms and cold fronts. The highest recorded wind in Los Alamos County was 34 meters per second (77 miles per hour). Surface winds often vary dramatically with the time of day, location, and elevation, due to Los Alamos' complex terrain.

In addition to seasonal changes in wind conditions, surface winds often vary with the time of day. An up-slope air flow often develops over the Pajarito Plateau in the morning hours. By noon, winds from the south usually prevail over the entire plateau. The prevalent nighttime flow ranges from the west-southwest to northwest over the western portion of the plateau. These nighttime winds result from cold air drainage off the Jemez Mountains and the Pajarito Plateau. Analyses of Los Alamos Canyon wind data indicate a difference between the atmospheric flow in the canyon and the atmospheric flow over the Pajarito Plateau. Cold air drainage flow is observed about 75 percent of the time during the night and continues for an hour or two after sunrise until an up-canyon flow forms. Wind conditions are discussed further in the *LANL SWEIS*.

Thunderstorms are common in Los Alamos County, with an average of 60 thunderstorms occurring in a year. Lightning can be frequent and intense. The average number of lightning-caused fires in the 1,104 hectares (2,727 acres) of Bandelier National Monument for the years 1990 through 1994 is 12 per year. There are no recorded instances of large-scale flooding in Los Alamos County. However, flash floods from heavy thunderstorms are possible in areas such as arroyos, canyons, and low-lying areas. No tornadoes are known to have touched the ground in the Los Alamos area.

4.2.3.1 Nonradiological Releases

LANL operations can result in the release of nonradiological air pollutants that may affect the air quality of the surrounding area. LANL is within the Upper Rio Grande Valley Intrastate Air Quality Control Region (#157). The area encompassing LANL and Los Alamos County is classified as an attainment area for all six criteria pollutants (i.e., carbon monoxide, nitrogen dioxide, lead, ozone, sulfur dioxide, and particulate matter) (40 CFR 81.332).

In addition to the National Ambient Air Quality Standards (NAAQS) established by the U.S. Environmental Protection Agency (EPA), the State of New Mexico has established ambient air quality standards for carbon monoxide, sulfur dioxide, nitrogen dioxide, total suspended particulates, hydrogen sulfide, and total reduced sulfur. Additionally, New Mexico established permitting requirements for new or modified sources of regulated air pollutants. Air quality permits have been obtained from the State Air Quality Bureau for beryllium operations, a rock crusher, and LANL's power plant that were modified or constructed after August 31, 1972. In accordance with Title V of the Clean Air Act, as amended, and New Mexico Administrative Code 202.72.402, the University of California and DOE submitted a sitewide operating permit application to New Mexico Environment Department in December 1995. The New Mexico Environment Department has reviewed this application and issued a Notice of Completeness, but has not yet issued an operating permit.

Criteria pollutants released from LANL operations are emitted primarily from combustion sources such as boilers, emergency generators, and motor vehicles. **Table 4–3** presents information regarding the primary

existing sources. Toxic air pollutant emissions from LANL activities are released primarily from laboratory, maintenance, and waste management operations. Unlike a production facility with well-defined operational processes and schedules, LANL is a research and development facility with great fluctuations in both the types of chemicals emitted and their emission rates. DOE has a program to review new operations for their potential to emit air pollutants.

Table 4–3 Air Pollutant Emissions at LANL in 1999

Pollutant	*LANL Sources Other Than TA-18 and TA-55 (metric tons per year)* [a]	*TA-18 Sources (metric tons per year)*	*TA-55 Sources (metric tons per year)*
Carbon monoxide	24.6	(b)	4.44
Nitrogen dioxide	73.5	(b)	5.97
PM_{10}	3.66	(b)	0.402
Sulfur dioxide	0.474	(b)	0.021

PM_{10} = particulate matter less than or equal to 10 microns in aerodynamic diameter.

[a] Emissions from the following were included: TA-3 Steam Plant; TA-21 Steam Plant; TA-16 Boilers; TA-48 Boiler; TA-53 Boiler; TA-59 Boiler; paper shredder; TA-3 Asphalt Plant; and TA-54 Water Pump. The inventory did not include various small sources such as residential-size boilers and standby emergency generators.

[b] Emissions from small heating units which burn propane or natural gas are small and are not included in the inventory.

Sources: DOE 1999b, LANL 2000f.

Only a limited amount of monitoring of the ambient air has been performed for nonradiological air pollutants within the LANL region. The New Mexico Environment Department operated a DOE-owned ambient air quality monitoring station adjacent to Bandelier National Monument between 1990 and 1994 to record sulfur dioxide, nitrogen dioxide, ozone, and particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) levels (see **Table 4–4**). LANL and the New Mexico Environment Department discontinued operation of this station in FY95 because recorded values were well below applicable standards. Beryllium monitoring performed in 1999 at 9 onsite stations, 10 perimeter stations, and 6 regional stations showed that beryllium levels were low. The New Mexico beryllium ambient standard has been repealed.

Table 4–4 Nonradiological Ambient Air Monitoring Results

Pollutant	*Averaging Period*	*Most Stringent Standard* [a] *(micrograms per cubic meter)*	*Ambient Concentration* [b] *(micrograms per cubic meter)*
Sulfur dioxide	Annual	41 [c]	2
	24 hours	205 [c]	18
	3 hours	1,030 [d]	Not applicable
Nitrogen dioxide	Annual	73.7 [c]	4
	24 hours	147 [c]	9
Ozone	1 hour	185 [d]	138
PM_{10}	Annual	50 [d]	8
	24 hours	150 [d]	29

PM_{10} = particulate matter less than or equal to 10 microns in aerodynamic diameter.

[a] The most stringent of the state and Federal standards are shown.

[b] 1994 ambient concentrations from monitoring site near Bandelier National Monument at TA-49.

[c] State standard.

[d] Federal standard (NAAQS).

Source: DOE 1999b.

Criteria pollutant concentrations attributable to existing LANL activities were estimated for the *LANL SWEIS* and are presented in **Table 4–5**.

For toxic air pollutants, a bounding analysis was performed for the *LANL SWEIS*, which indicated that the pollutants of concern for exceeding the guideline values at LANL were emissions from the High Explosives Firing Site operations and emissions that contributed to additive risk from all TAs on receptors near the

Los Alamos Medical Center. These combined cancer risks were dominated by the chloroform emissions from the Health Research Laboratory. It was shown that pollutants released under the No Action Alternative in the *LANL SWEIS* are not expected to cause air quality impacts that would affect human health and the environment. Although various small quantities of toxic air pollutants are emitted from activities at TA-18, no toxic air pollutant emissions were identified from TA-18 that would be expected to have an adverse air quality impact (LANL 2001a).

Table 4–5 Modeled Ambient Air Concentrations from LANL Sources

Pollutant	*Averaging Period*	*Most Stringent Standard* [a] *(micrograms per cubic meter)*	*Maximum Estimated Concentration* [b] *(micrograms per cubic meter)*
Carbon monoxide	8 hours 1 hour	7,800 11,700	1,440 2,710
Lead	Calendar quarter	1.5	0.00007
Nitrogen dioxide	Annual 24 hours	73.7 147	9 90
PM_{10}	Annual 24 hours	50 150	1 9
Sulfur dioxide	Annual 24 hours 3 hours	41 205 1,030	18 130 254
Total suspended particulates	Annual 24 hours	60 150	2 18

[a] The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic PM_{10} mean standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. Standards and monitored values for pollutants other than particulate matter are stated in parts per million (ppm). These values have been converted to micrograms per cubic meter ($\mu g/m^3$) with appropriate corrections for temperature (21 °C [70 °F]) and pressure (elevation 2,135 meters [7,005 feet), following New Mexico dispersion modeling guidelines (revised 1998) (NMAQB 1998).

[b] Based on the Expanded Operations Alternative in the *LANL SWEIS*. The annual concentrations were analyzed at locations to which the public has access–the site boundary or nearby sensitive areas. Short term concentrations were analyzed at the site boundary and at the fence line of certain technical areas to which the public has short access.

Source: DOE 1999b.

As reported in a special environmental analysis for the Cerro Grande Fire in 2000 (DOE 2000g), there may be some temporary increase in suspended particulate matter as a result of removal of vegetation cover, but air quality would be expected to be within the parameters analyzed in the *LANL SWEIS*.

In accordance with the Clean Air Act, as amended, and New Mexico regulations, the Bandelier National Monument and Wilderness Area have been designated as a Class I area (i.e., wilderness areas that exceed 4,047 hectares [10,000 acres]), where visibility is considered to be an important value (40 CFR 81 and 20 New Mexico Administrative Code 2.74) and requires protection. Visibility is measured according to a standard visual range, i.e., how far an image is transmitted through the atmosphere to an observer some distance away. Visibility has been officially monitored by the National Park Service at the Bandelier National Monument since 1988. The view distance at Bandelier National Monument has been recorded from approximately 77 to 166 kilometers (40 to 103 miles). The visual range has not deteriorated during the period for which data are available.

4.2.3.2 Radiological Releases

Radiological air emissions in 1999 from all LANL TAs are presented in **Table 4–6**. Radiological air emissions from TA-18 and TA-55 are also shown in the table. The airborne releases in 1999 were smaller than the annual projections given in the *LANL SWEIS*. Specifically, for TA-18, the 1999 release of argon-41

was 0.49 curies, compared with the maximum annual projection of 110 curies (see Section 3.2.1); and for TA-55, the 1999 release of tritium was 1.8 curies, compared with the annual projection of 1,000 curies. The difference in the projected and actual releases are attributable to the fact that the facilities in the areas were operated well below their capacities in 1999.

Table 4–6 Radiological Airborne Releases to the Environment at LANL in 1999[a]

Emission Type	*Radionuclide*	*LANL (curies)*	*TA-18 (curies)*	*TA-55 (curies)*
Noble gases	Argon-41	14.2	0.49 [b]	—
Airborne particulates	Cobalt-60	3.97×10^{-6}	—	—
	Galluim-68	0.00173	—	—
	Germanium-68	0.00173	—	—
	Arsenic-73	1.83×10^{-5}	—	—
	Arsenic-74	4.49×10^{-5}	—	—
	Selenium-75	3.50×10^{-4}	—	—
	Mercury-197	0.00160	—	—
	Uranium-234/235/238	7.72×10^{-6}	—	7.1×10^{-8}
	Plutonium-238/239/240	2.11×10^{-5}	—	6.3×10^{-8}
	Americum-241	2.78×10^{-6}	—	5.4×10^{-8}
Halogens	Bromine-76	2.32×10^{-4}	—	—
	Bromine-77	1.15×10^{-5}	—	—
	Bromine-82	6.27×10^{-4}	—	—
Nitrogens and oxygens	Nitrogen-13	159	—	—
Tritium and carbons	Tritium (Hydrogen-3)	1,603	—	1.8
	Carbon-11	283 [b]	—	—

[a] Radionuclides with half-lives less than about 10 minutes are not included in the table (e.g., short-lived carbon, oxygen, and nitrogen isotopes). Also, not included are radionuclides for which less than 10^{-6} curies are released per year.

[b] Includes nonpoint source emissions of activated air from the Los Alamos Neutron Science Center Facility and TA-18.

Note: Dashed lines indicate virtually no releases.

Source: LANL 2000f.

4.2.4 Noise

Existing LANL-related publicly detectable noise levels are generated by a variety of sources, including truck and automobile movements to and from the LANL TAs, high explosives testing, and security guards' firearms practice activities. Noise levels within Los Alamos County unrelated to LANL are generated predominately by traffic movements and, to a much lesser degree, other residential-, commercial-, and industrial-related activities within the county communities and the surrounding areas. Limited data currently exist on the levels of routine background ambient noise levels, air blasts, or ground vibrations produced by LANL operations that include explosives detonations.

Traffic noise contributes heavily to the background noise heard by humans over most of the county. Although some measurements of sound specifically targeting traffic-generated noise have been made at various county locations in recent studies, these sound levels are found to be highly dependent upon the exact measuring location, time of day, and meteorological conditions. There is, therefore, no single representative measurement of ambient traffic noise for the LANL site. Noise generated by traffic has been computer modeled to estimate the impact of incremental traffic for various studies, including recent NEPA analyses, without demonstrating meaningful change from current levels due to any new activities. While very few measurements of nonspecific background ambient noise in the LANL area have been made, two such measurements have been taken at a couple of locations near the LANL boundaries next to public roadways. Background noise levels were found to range from 31 to 35 decibels A-weighted (dBA) at the vicinity of the

entrance to Bandelier National Monument and New Mexico Route 4 (NM 4). At White Rock, background noise levels range from 38 to 51 dBA (one-hour equivalent sound level); this is slightly higher than was found near Bandelier National Monument, probably due to higher levels of traffic and the presence of a residential neighborhood, as well as the different physical setting. The detonation of high explosives represents the peak noise level generated by LANL operations. The results of these detonations are air blasts and ground vibrations.

The primary source of these detonation activities is the high explosives experiments conducted at the LANL Pulsed High-Energy Radiation Machine Emitting X-Rays Facility and surrounding TAs with active firing sites. Within the foreseeable future, the Dual Axis Radiographic Hydrodynamic Test Facility will begin operation (followed by a corresponding reduction of Pulsed High-Energy Radiation Machine Emitting X-Rays Facility operations) and will become a source of high explosives testing. Explosives detonations were performed in March 1995 for the *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement* (DOE 1995e) analysis, and measurements of air blasts and ground vibrations were obtained for representative Pulsed High-Energy Radiation Machine Emitting X-Rays Facility explosives tests.

Air blasts consist of higher-frequency, audible air pressure waves that accompany an explosives detonation. This noise can be heard by both workers and the area public. The lower-frequency air pressure waves are not audible, but may cause secondary and audible noises within a testing structure that may be heard by workers. Air blasts and most LANL-generated ground vibrations result from testing activities involving above-ground explosives research. The effects of vibration from existing activities at LANL are discussed further in the *LANL SWEIS*.

The forested condition of much of LANL (especially where explosives testing areas are located); the prevailing area atmospheric conditions; and the regional topography that consists of widely varied elevations and rock formations all influence how noise and vibrations can be both attenuated (lessened) and channeled away from receptors. These regional features are jointly responsible for there being little environmental noise pollution or ground vibration concerns to the area resulting from LANL operations. Sudden loud "booming" noises associated with explosives testing are similar to the sound of thunder and may occasionally startle members of the public and LANL workers alike.

Loss of large forest areas from the Cerro Grande Fire in 2000 has had an adverse effect on the ability of the surrounding environment to absorb noise. However, types of noise and noise levels associated with LANL and from activities in surrounding communities have not changed significantly as a result of the fire (DOE 2000g).

Noise generated by LANL operations, together with the audible portions of explosives air blasts, is regulated by county ordinance and worker protection standards. The standard unit used to report sound pressure levels is the decibel (dB); the A-weighted frequency scale (dBA) is an expression of adjusted pressure levels by frequency that accounts for human perception of loudness. Los Alamos County has promulgated a local noise ordinance that establishes noise level limits for residential land uses. Noise levels that affect residential receptors are limited to a maximum of 65 dBA during daytime hours (between 7 a.m. and 9 p.m.) and 53 dBA during nighttime hours (between 9 p.m. and 7 a.m). Between 7 a.m. and 9 p.m., the permissible noise level can be increased to 75 dBA in residential areas, provided the noise is limited to 10 minutes in any one hour. Activities that do not meet the noise ordinance limits require a permit.

The Los Alamos County Community Development Department has determined that LANL does not need a special permit under the Los Alamos County Code because noise related to explosives testing is not prolonged, nor is it considered unusual to the Los Alamos community.

Traffic noise from truck and automobile movements around the LANL TAs is excepted under Los Alamos County noise regulations, as is the traffic noise generated along public thoroughfares within the county.

The vigor and well being of area wildlife and sensitive, federally protected bird populations suggest that these environmental conditions are present at levels within an acceptable tolerance range for most wildlife species and sensitive nesting birds found along the Pajarito Plateau.

4.2.5 Geology and Soils

LANL is located on the Pajarito Plateau within the Southern Rocky Mountains Physiographic Province. The Pajarito Plateau lies between the Sierra de Los Valles and the Jemez Mountains to the west and the Rio Grande to the east. The surface of the Pajarito Plateau is divided into numerous narrow, finger-like mesas separated by deep east-to-west-oriented canyons that drain toward the Rio Grande. A primary geologic feature in the region is the Rio Grande Rift, which begins in northern Mexico, trends northward across central New Mexico, and ends in central Colorado. The rift is a complex system of north-trending basins that have formed by downfaulting of large blocks of the Earth's crust. In the Los Alamos area, the Rio Grande Rift is about 56 kilometers (35 miles) wide and encompasses the Española Basin. The Sangre de Cristo Mountains border the Rio Grande Rift on the east, and the Jemez Mountains lie over the western fault margin of the rift. The north-trending Pajarito Fault system is part of the Rio Grande Rift and consists of a group of interconnecting faults that are nearly parallel.

In summary, the rocks present in the LANL region were predominantly produced by volcanic and sedimentary processes. The Pajarito Plateau is capped by the Bandelier Tuff. This unit attains a thickness of more than 200 meters (700 feet) in the LANL region and consists of ash-flow deposits of rhyolitic tuff and pumice, erupted between about 1.2 and 1.6 million years ago during the early to middle Quaternary period (i.e., Pleistocene) from the Valles and Toledo calderas located in the Jemez Mountains volcanic field (located west of LANL). Older, underlying units include the Puye Formation, which is a sedimentary unit comprised from materials derived from the Jemez Mountains and the ancestral Rio Grande and intruded in places by Cerros del Rio basalt flows. Underlying it is the Tschicoma Formation which consists of volcanic vent deposits. The Santa Fe Group is the most extensive unit in the Rio Grande Rift and largely consists of sedimentary materials and rocks including evaporites derived from stream or deltaic deposits, but also contains volcanic tuff deposits and basalts. The Sante Fe Group sits atop Precambrian age (greater than 570 million years old) crystalline basement rock. Additional details about LANL site geology are presented in the *LANL SWEIS*.

There are no active mines, mills, pits, or quarries in Los Alamos County or on DOE land at LANL. However, rock and mineral resources including sand, gravel, and volcanic pumice are mined throughout the surrounding counties. Sand and gravel are primarily used in construction, including for road building, and pumice is used in textile laundries to soften material and as an abrasive, as well as for building blocks and in landscaping. The major sand and gravel deposit in the area is located in the lower member of the Puye Conglomerate. The welded and moderately welded units of the Bandelier Tuff are suitable as foundation rocks, structural and ornamental stone, or insulating material. Volcanic tuff has also been used successfully as aggregate in soil-cement subbases for roads.

The nearby north-trending Pajarito Fault system dominates the geologic structure of the LANL area. The Pajarito Fault system consists of three major faults and numerous secondary faults. The major faults in Los Alamos County are the Pajarito, Rendija Canyon, and Guaje Mountain (see **Figure 4–4**). Estimates of the most recent movements along the faults are based on trench studies where the faults are not buried. The estimates of movement range from as recent as 4,000 years ago for the Guaje Mountain Fault to 55,000 years ago for the Pajarito Fault, with estimated movement along the Rendija Canyon Fault occurring between 8,000

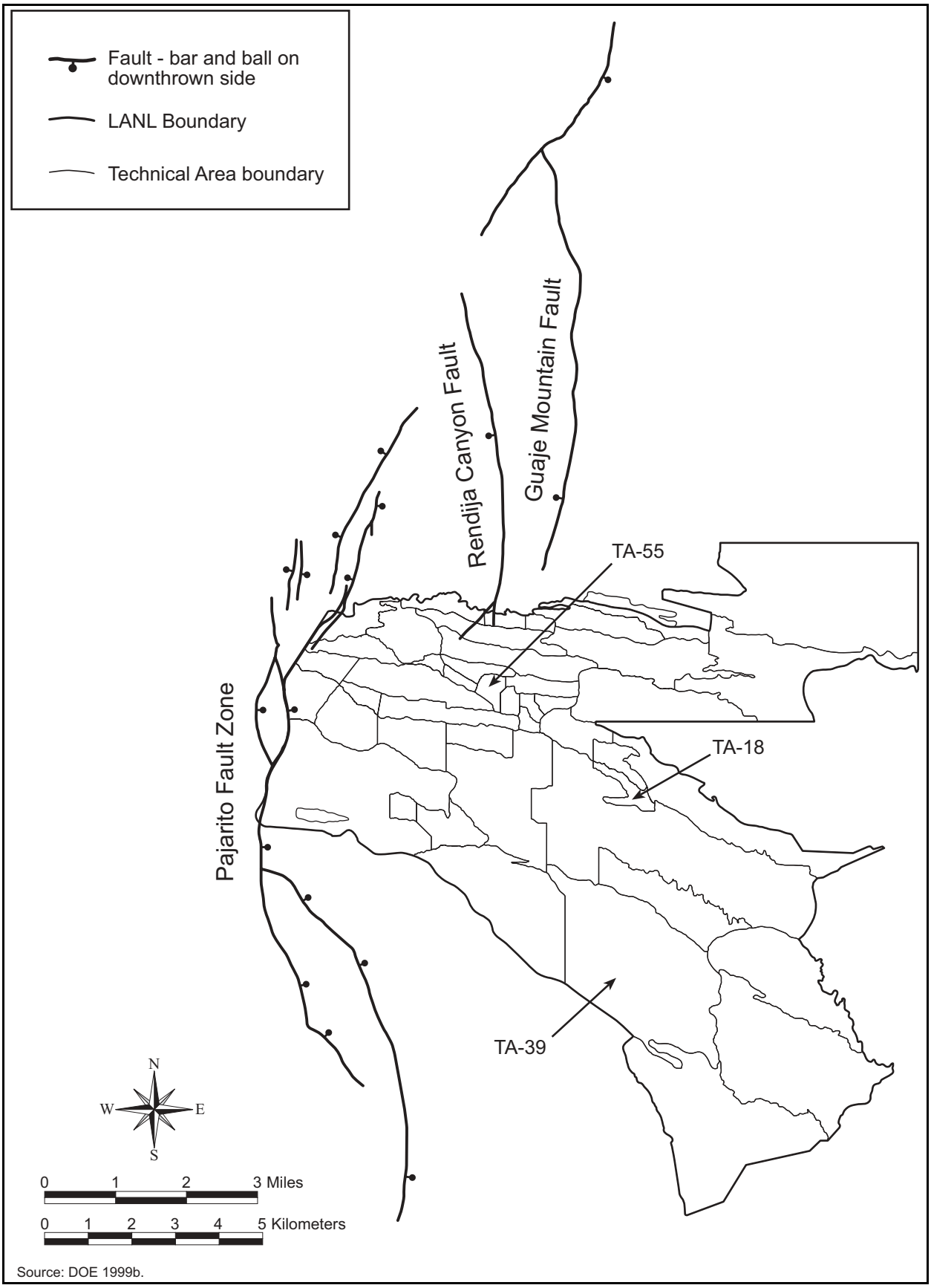


Figure 4–4 Major Faults at LANL

and 23,000 years ago. It is possible that the most recent movements along the faults are younger than those presented. Therefore, these faults should be considered active and capable per the U.S. Nuclear Regulatory Commission definition of the term as used for seismic safety. A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years (10 CFR Part 100, Appendix A). Additional detail on ongoing seismic studies and their implications can be found in the *LANL SWEIS* and supplemental analyses that considered the seismic setting at TA-55.

LANL is located in a region of generally low to moderate seismicity overall. A historical catalog has been compiled of earthquakes that have occurred in the LANL area from 1873 to 1991. Only six of these have had estimated magnitudes of 5 or greater on the Richter scale. The May 1918 Cerrillos Earthquake was the most significant seismic event in this period. This earthquake had an estimated Richter magnitude of 5.5 and was centered approximately 31 miles (50 kilometers) southeast of LANL. This event had a reported Modified Mercalli Intensity of VII at its epicenter. Within a radius of 100 kilometers (62 miles) of central LANL, a total of five significant earthquakes (i.e., having a magnitude of at least 4.5 or a Modified Mercalli Intensity of VI or larger) have been documented, including the May 1918 event (USGS 2001b). Since 1973, six earthquakes have been recorded within 100 kilometers (62 miles) of central LANL ranging in magnitude from 1.6 to a magnitude 4.5 event in March 1973. This 1973 earthquake was the closest to LANL at 28 kilometers (16 miles) to the northeast. The most recent was a magnitude 2.8 earthquake that occurred in December 1998 at a distance of 86 kilometers (53 miles) (USGS 2001a).

Earthquake hazard results indicate that the Pajarito Fault system represents the greatest potential risk to LANL, with an estimated maximum earthquake magnitude of about 7. Although large uncertainties exist, an earthquake with a Richter magnitude greater than or equal to 6 is estimated to have an annual probability of occurrence of 1 in 4,000 (i.e., once every 4,000 years); an earthquake with a magnitude greater than or equal to 7 is estimated to have an annual probability of occurrence of 1 in 100,000 along the Pajarito Fault system. The hazard study of facilities in eight LANL TAs found that earthquakes having an annual probability of occurrence of 1 in 10,000 would cause a horizontal peak ground acceleration ranging from 0.53g to 0.57g. Measures of peak (ground) acceleration indicate what an object on the ground would experience during an earthquake. This motion is customarily expressed in units of g (gravitational acceleration). Maintenance and refurbishment activities at LANL are specifically intended to upgrade the seismic performance of older structures. For reference, a comparison of Modified Mercalli Intensity (the observed effects of earthquakes) with measures of earthquake magnitude and ground acceleration is provided in Section F.5.2 (see Appendix F).

While peak acceleration is generally adequate to approximate what a short structure would experience in terms of horizontal force during an earthquake, it does not account for the range of energies experienced by a building during an earthquake, particularly for taller buildings. Thus, building design based on peak acceleration alone does not provide a uniform margin against collapse. However, the U.S. Geological Survey has developed new seismic hazard metrics and associated National Earthquake Hazard Reduction Program maps that are based on response spectral acceleration (spectral acceleration).

Spectral acceleration accounts for the natural period of vibration of structures (i.e., short buildings have short natural periods [up to 0.6 seconds] and taller buildings longer periods [0.7 seconds or longer]) (USGS 2001j). The National Earthquake Hazard Reduction Program maps have been adapted for use in the new *International Building Code* (ICC 2000), and depict maximum considered earthquake ground motion of 0.2- and 1-second spectral response acceleration, respectively, based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual recurrence interval of about 1 in 2,500. The central portion of LANL (encompassing TA-18 and TA-55) is calculated to lie within the 0.57 g to 0.58 g mapping contours for a 0.2-second spectral response acceleration and the 0.18 g to 0.19 g contours for a 1-second spectral

response acceleration. For comparison, the calculated peak ground acceleration for the given probability of exceedance is approximately 0.25 g (USGS 2001e).

Volcanism in the Jemez Mountains volcanic field, west of LANL, has a 13-million-year history. The Bandelier Tuff is the material upon which most LANL facilities are constructed. The Bandelier Tuff is generally thickest to the west of LANL near its source, and thins eastward across the Pajarito Plateau, due to increasing distance from the source and erosion. Volcanic eruptions continued up to about 520,000 years ago, followed by a 460,000-year period of dormancy. The most recent volcanic activity produced several rock units, including the El Cajete pumice, which is a minor unit in the LANL area that overlays the Bandelier Tuff. The El Cajete pumice dates at 50,000 to 60,000 years old. Recurrence intervals for future volcanism have not been established.

Facilities near a cliff edge or in a canyon bottom are potentially susceptible to slope instability and specifically are susceptible to the geologic hazards of rockfalls and landslides. Slope stability studies have been performed at these and other facilities where a hazard has been identified. As for other geologic hazards, the potential for land subsidence and soil liquefaction at LANL is considered low.

Several distinct soils have developed in Los Alamos County as a result of interactions between the bedrock, topography, and local climate. Most soils developed from acidic volcanic rock and range in texture from clay and clay loam to gravel. Rock outcrops are common occurring on greater than 50 percent of the surface (DOE 1996f). Soils that formed on mesa tops are well drained and range from very shallow (0 to 25 centimeters [0 to 10 inches]) to moderately deep (51 to 102 centimeters [20 to 40 inches]), with the greatest depth to the underlying Bandelier Tuff being 102 centimeters (40 inches). Soil erosion rates vary considerably on the mesa tops at LANL, with the highest rates occurring in drainage channels, where roads and structures concentrate runoff, and in areas of steep slopes and the lowest rates occurring on gently sloping portions of the mesa tops away from the channels. A recent study suggested that erosion rates are high across widespread portions of local pinyon-juniper woodlands, which are found on the eastern portion of LANL. High erosion rates appear to be relatively recent, most likely resulting from loss of vegetative cover, decreased precipitation, past logging practices, and past livestock grazing (DOE 1999b). Site soils are acceptable for standard construction techniques. No prime farmland soils have been designated in Los Alamos County (DOE 1996e).

The Cerro Grande Fire has increased the potential for soil erosion across areas burned at LANL due to the loss of vegetation and has also destabilized rocks close to the edges of mesas, mesa side slopes, and canyon bottoms. While the postburn assessment conducted by the U.S. Forest Service Burn Area Emergency Rehabilitation Team found that the Cerro Grande Fire created hydrophobic (water repellent) soil conditions, resulting in an increased runoff rate along rather appreciable tracts of land located just to the northwest of LANL, no significant areas of hydrophobic soils were found within LANL. These effects are expected to persist for some three to five years (DOE 2000g).

TA-18 is located approximately 5.3 kilometers (3.3 miles) southeast of the mapped terminating point of the Rendija Canyon Fault (see Figure 4–4). This fault is the nearest capable fault to TA-18. Typical subsurface stratigraphy at LANL and TA-18 consists of welded and poorly welded volcanic tuffs that comprise the Tshirege Member of the Bandelier Tuff Formation. The Tshirege Member attains a thickness of about 122 meters (400 feet) (DOE 1995e). Site-specific investigations in Pajarito Canyon near TA-18 have found the tuff to be highly weathered and unwelded, with the upper 3 to 4.5 meters (10 to 15 feet) of the material classified as clayey sand or sandy clay. However, surrounding cliff faces consist of welded tuff exhibiting vertical jointing. The canyon tuff is overlain by up to 4.5 meters (15 feet) of sandy and silty alluvium (URS 2000). Soils derived from these deposits are typically sandy loams (DOE 1995e). In general, sandy

soils occurring where the water table or perched water bodies lie near the surface present a potential for liquefaction.

TA-55 is located just to the southwest of the southern terminus of Rendija Canyon Fault, which is located about 1.3 kilometers (0.8 miles) northwest of the facility. Site stratigraphy is generally expected to be similar to that described above for TA-18, except that the thickness of overlying alluvium is thinner.

4.2.6 Water Resources

4.2.6.1 Surface Water

Surface water in the Los Alamos area occurs primarily as short-lived or intermittent reaches of streams (i.e., arroyos). Perennial springs on the flanks of the Jemez Mountains supply base flow into the upper reaches of some canyons, but the volume is insufficient to maintain surface flows across the LANL site before they are depleted by evaporation, transpiration, and infiltration. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande, the major river in north-central New Mexico, several times a year in some drainages. Effluent from sanitary sewage, industrial water treatment plants, and cooling-tower blowdown enter some canyons at rates sufficient to maintain surface flows for varying distances. Major watersheds in the LANL region are shown in **Figure 4–5**. All of these watersheds are tributaries to an 18-kilometer (11-mile) segment of the Rio Grande between Otowi Bridge and Frijoles Canyon. The Rio Grande passes through Cochiti Lake, approximately 18 kilometers (11 miles) below Frijoles Canyon. The Los Alamos Reservoir, in upper Los Alamos Canyon, has a capacity of 51,000 cubic meters (41 acre-feet). The reservoir water is used for recreation, swimming, fishing, and landscape irrigation in the Los Alamos town site. The Pajarito Plateau Canyons, which serve as collection points for the regional watersheds, originate either along the eastern rim of the Sierra de Los Valles or on the Pajarito Plateau. Within LANL boundaries, only Los Alamos, Pajarito, Water, Ancho, Sandia, Pueblo, and Chaquehui Canyons contain reaches or streams with sections that have continuous flow. Intermittent streams within LANL property are not classified, but are protected by the State of New Mexico for livestock watering and wildlife habitat use (New Mexico Administrative Code 20.6.4.10). Surface water within LANL boundaries is not a source of municipal, industrial, or irrigation water, but is used by wildlife that live within, or migrate through, the region.

Most of LANL effluent is discharged into normally dry arroyos, and LANL is required to meet effluent limitations under the National Pollutant Discharge Elimination System (NPDES) permit program that requires routine effluents monitoring. Therefore, the water quality of the intermittent streams is more characteristic of the quality of these discharges than of natural runoff, as reflected in the results of 1999 surface water and runoff monitoring. LANL's current NPDES permit (No. NM0028355), which was reissued in December 2000, covers all onsite industrial and sanitary effluent discharges, and DOE and the University California are co-permittees. As a result of an outfall reduction program, the number of outfalls requiring monitoring under the permit was reduced from 36 (including 1 sanitary outfall from the Sanitary Wastewater Systems Facility and 35 industrial wastewater outfalls) to 21 in the recently reissued permit. This reduction was achieved by removing process flows for 7 industrial outfalls and completing the lease transfer of the drinking water system, including 9 associated outfalls, to Los Alamos County. During 1999, permit compliance was determined from analysis of 1,250 industrial outfall samples and 175 samples from the Sanitary Wastewater Systems Facility (Outfall 13S) for such parameters as metals, radionuclides, and conventional parameters (e.g., pH, total suspended solids, etc.). Monitoring results are submitted to EPA and to the New Mexico Environment Department. The NPDES permit compliance rate for all discharge points was 98.9 percent, with a total of 16 industrial outfall samples exceeding permit limits (LANL 2000f). Industrial and sanitary effluent management is discussed further in Section 4.2.12.5.

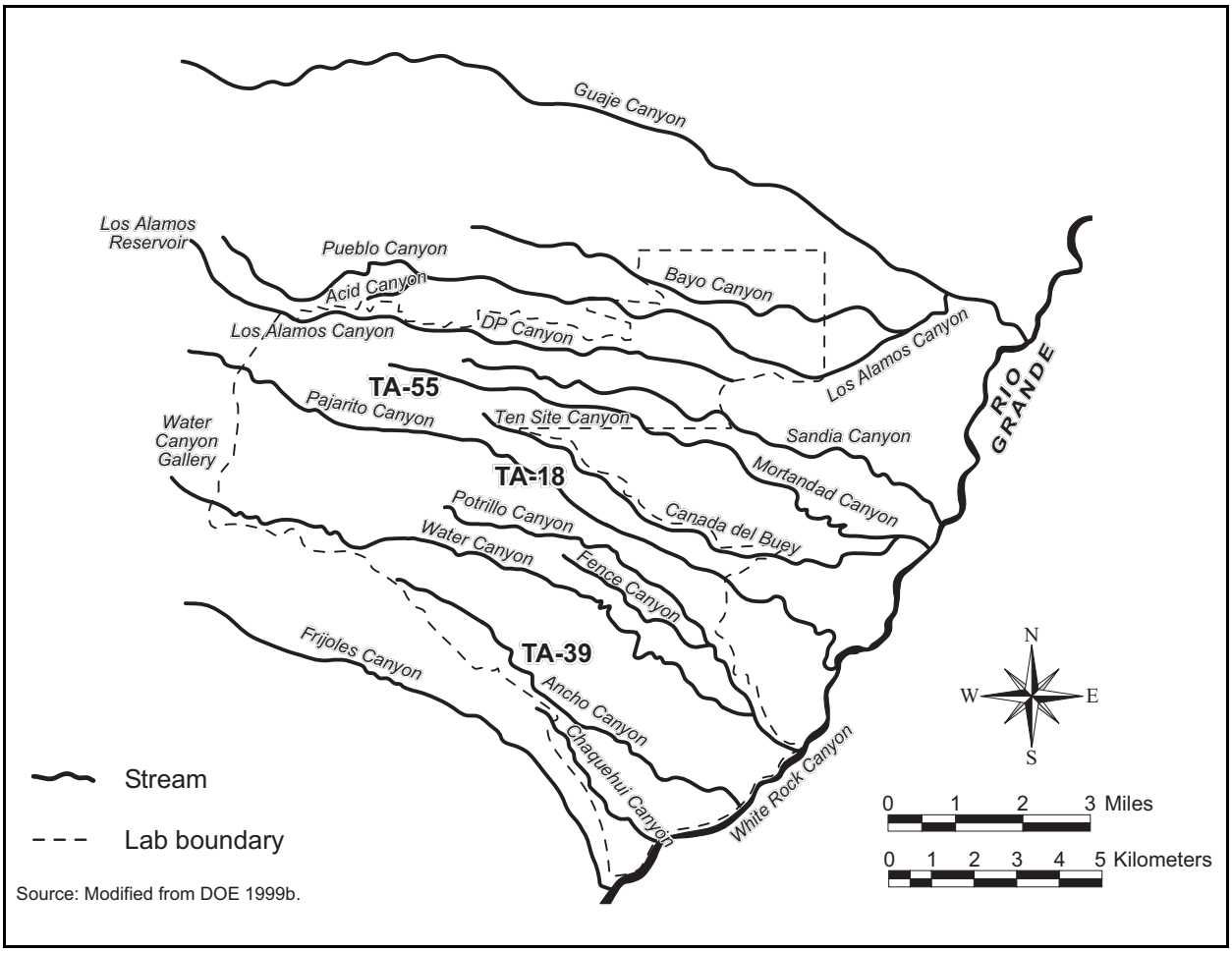


Figure 4–5 Surface Water Features at LANL

LANL also operated under seven NPDES stormwater discharge permits in 1999, including six issued for construction activities and one multisector general permit for stormwater discharges associated with industrial activity for which DOE and the University of California are also co-permittees. As required under this general permit, LANL performed stormwater monitoring in 1999 and developed and implemented 22 storm-water pollution prevention plans for its industrial activities (LANL 2000f).

LANL monitors surface waters from regional and Pajarito Plateau stations to evaluate the environmental effects of facility operations. Historical activities and resulting effluent discharges have affected water courses and associated sediments particularly in Acid, Pueblo, Los Alamos, and Mortandad Canyons and, consequently, continue to affect surface water and runoff quality in these areas (LANL 2000f). Surface water grab samples are collected annually from locations where effluent discharges or natural runoff maintains stream flow. Runoff samples are also collected and, since 1996, they have been collected using stream gaging stations, some with automated samplers. Samples are collected when a significant rainfall event causes flow in a monitored portion of a drainage. Many runoff stations are located where drainages cross the LANL boundaries. Detailed information on surface water and stormwater runoff monitoring including analytical results are contained in the annual site environmental report (LANL 2000f).

Among the environmental effects produced by the Cerro Grande Fire was an increased potential for stormwater runoff through the canyons that cross LANL property as a result of the loss of vegetation and soil organic matter. It is expected that soil erosion rates and corresponding sediments loads in runoff from

denuded watersheds will be much higher than prefire levels for many years resulting in the potential for sediment and debris-laden runoff to reach the Rio Grande. It is also likely that runoff and ambient water quality in canyon drainages will be temporarily reduced by the increase in suspended sediment and by the liberation of organic nitrogen from fire-burned soils, the latter of which can also impact shallow groundwater (DOE 2000g).

DOE has delineated all 100-year floodplains within LANL boundaries, which are generally associated with canyon drainages. There are a number of structures within the 100-year floodplain. Most may be characterized as small storage buildings, guard stations, well heads, water treatment stations, and some light laboratory buildings. There are no waste management facilities in the 100-year floodplain. Some facilities are characterized as "moderate hazard" due to the presence of sealed sources or x-ray equipment, but most are designated "low hazard" or "no hazard". The 500-year floodplain has been designated for Los Alamos Canyon. Overall, most laboratory development is on mesa tops, and development within canyons is light (DOE 2000g). Nevertheless, for practical purposes the Cerro Grande Fire has increased the extent of all delineated floodplains in and below burned watershed areas (i.e., predominantly Los Alamos, Sandia, Mortandad, Pajarito, and Water Canyons) due to vegetation loss. This will allow more stormwater runoff to reach the canyon bottoms and could subject LANL facilities located within or near the prefire delineated floodplain areas to increased erosion or sediment and debris deposition (DOE 2000g).

TA-18 contains no permanent, natural, surface water bodies, and the reach of the Pajarito Canyon near the developed area is not perennial. Portions of the facility complex are located within the 100-year floodplain associated with Pajarito Canyon. TA-18 is located at the confluence of Pajarito and Threemile Canyons. These watersheds were among those impacted by the Cerro Grande Fire, which substantially increased the postburn peak runoff flow rate in the canyons. For Pajarito Canyon at TA-18, hydrologic modeling indicates that the peak flow for stormwater runoff from the 6-hour, 100-year storm has increased from a pre-burn rate of 4.13 cubic meters per second (146 cubic feet per second) to an estimated 70.6 cubic meters per second (2,492 cubic feet per second) (DOE 2000g). Nevertheless, DOE has taken steps to ensure that the facility is protected from flooding associated with the postfire 100-year storm. This has included the construction of additional structural controls including a new flood retention structure upstream from the facility, a trash rack to retain flood debris, excavated flow channel, and installation of metal sheet piling to divert floodwaters and to protect individual structures from flood-propelled projectiles (LANL 2000c).

TA-55 contains no permanent, natural surface water bodies and the developed areas are not located within a delineated floodplain.

4.2.6.2 Groundwater

Groundwater in the Los Alamos area occurs as perched groundwater near the surface in shallow canyon bottom alluvium and at deeper levels in the main (regional) aquifer (LANL 2000f). Most aquifers underlying LANL and vicinity, except for perched groundwater bodies, are considered Class II aquifers (i.e., those currently used or potentially available for drinking water or other beneficial use). Alluvial groundwater bodies within LANL boundaries have been primarily characterized by drilling wells on a localized basis where LANL operations are conducted. Wells in Mortandad, Los Alamos, Pueblo, and Pajarito Canyons and in Cañada del Buey indicate the presence of continually saturated alluvial groundwater bodies. Intermediate perched groundwater bodies of limited extent are known to occur within the conglomerates and basalts beneath the alluvium in portions of Pueblo, Los Alamos, and Sandia Canyons; in volcanic rocks on the sides of the Jemez Mountains to the west of LANL, from which it discharges at spring heads; and on the western portion of the Pajarito Plateau (LANL 2000f).

The locations and extent of perched groundwater bodies have not been fully characterized at LANL, but investigations are continuing, and unidentified perched aquifers may exist. The depth to perched groundwater from the surface ranges from approximately 27 meters (90 feet) in the middle of Pueblo Canyon to about 137 meters (450 feet) in lower Sandia Canyon. The regional aquifer exists in the sedimentary and volcanic rocks of the Española Basin, with a lateral extent from the Jemez Mountains in the west to the Sangre de Cristo Mountains in the east (see **Figure 4–6**). The hydrostratigraphic (water-bearing) units comprising the regional aquifer include the interconnected Puye Formation and the Tesuque Formation of the Santa Fe Group, with the top of the aquifer originating in the Cerros del Rio Formation, rather than in the Puye Formation, in some locations. Groundwater flow paths are conceptually illustrated in Figure 4–6. Groundwater flow is generally to the east.

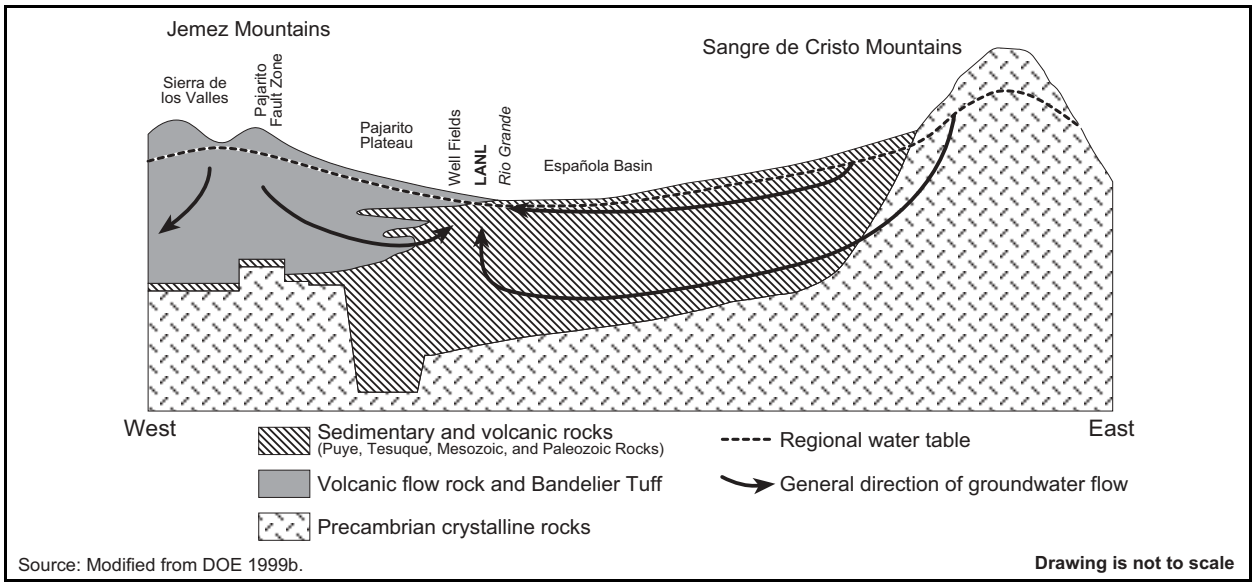


Figure 4–6 Hydrogeology of the Española Portion of the Northern Rio Grande Basin

The regional aquifer is hydraulically separated for practical purposes from the overlying alluvial and intermediate perched groundwater bodies by unsaturated volcanic tuff and sedimentary strata, with the regional water table surface lying at a depth below land surface that varies from approximately 366 meters (1,200 feet) along the western boundary of the Pajarito Plateau to approximately 183 meters (600 feet) along its eastern edge. Thus, these hydrogeologic conditions tend to insulate the regional aquifer from near-surface waste management activities. Water in the regional aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande.

Recharge of the regional aquifer has not been fully characterized and sources are uncertain; data suggest that the regional aquifer of the Española Basin is not strongly interconnected across its extent. Recent investigations further suggest that the majority of water pumped to date has been from storage, with minimal recharge of the regional aquifer. While the regional aquifer is present beneath all watersheds across the LANL region, it is also generally considered to receive negligible recharge from surface water streams in the watersheds. Springs in the LANL area originate from alluvial and intermediate perched groundwater bodies and the regional aquifer and occur in the Guaje, Pueblo, Los Alamos, Pajarito, Frijoles, and White Rock Canyon watersheds. In particular, 27 springs discharge from the regional aquifer into White Rock Canyon. A perched aquifer yields a relatively high flow to a former potable water supply gallery in Water Canyon (LANL 2000f).

Short-term effects of the Cerro Grande Fire on LANL groundwater resources include a potential increase in the prevalence of perched groundwater and springs. Also, as discussed for surface water, the liberation of organic nitrogen from burned soils could impact shallow groundwater in the perched and alluvial zones although the effects on deeper groundwater resources are not known (DOE 2000g).

Groundwater monitoring is conducted within and near LANL and encompasses the alluvial zone, intermediate perched groundwater zone, regional aquifer, and springs. However, although largely insulated from effects resulting from surface activities by hydrogeologic conditions, resource management and protection efforts are focused on the regional aquifer, which is the water supply source for the Los Alamos public water supply. The groundwater monitoring network for alluvial groundwater consists of shallow observation wells located in Mortandad, Los Alamos, Pueblo, and Pajarito Canyons and in Cañada del Buey. Perched groundwater is monitored from two test wells and one spring (i.e., the Water Canyon Gallery). The monitoring network for the regional aquifer includes 8 deep test wells completed by the U.S. Geological Survey, 13 deep supply wells that produce water for all of LANL and the surrounding communities, and from numerous springs, including those in White Rock Canyon (LANL 2000f).

As previously indicated, canyon bottom alluvial groundwater in Pueblo, Los Alamos, and Mortandad Canyons receives effluent and has been affected by it. Most notably, Mortandad Canyon groundwater samples during 1999 exceeded or approached the New Mexico groundwater standards for fluoride and nitrate. The nitrate source is nitric acid from plutonium processing at TA-55 that enters the TA-50 waste stream. However, corrective action measures instituted at the Radioactive Liquid Waste Treatment Facility have had a positive impact on nitrogen waste discharges and associated groundwater concentrations. Detailed information on groundwater monitoring, including analytical results, is presented in the annual site environmental report (LANL 2000f).

The main aquifer is the only body of groundwater in the region that is sufficiently saturated and permeable to transmit economic quantities of water to wells for public use. All drinking water for Los Alamos County, LANL, and Bandelier National Monument comes from the main aquifer. Water use is detailed in Section 4.2.2.4.

TA-18 is immediately underlain by alluvial groundwater. The depth to the regional aquifer beneath the site is approximately 261 meters (855 feet) and the flow is expected to be to the southeast (LANL 2001a).

The depth to groundwater beneath TA-55 is approximately 390 meters (1,280 feet) and the flow is expected to be to the east and southeast (LANL 2001a). As discussed above, effluent from TA-55 is conveyed through the TA-50 wastewater treatment facility and then discharged to Mortandad Canyon.

4.2.7 Ecological Resources

4.2.7.1 Terrestrial Resources

LANL lies within the Colorado Plateau Province. Ecosystems within the laboratory site itself are quite diverse, due partly to the 1,525-meter (5,000-foot) elevational gradient from the Rio Grande on the southeastern boundary to the Jemez Mountains, 20 kilometers (12.4 miles) to the west, and to the many canyons with abrupt slope changes that dissect the site. Only a small portion of the total land area at LANL has been developed (DOE 1996f). In fact, only 5 percent of the site is estimated to be unavailable to most wildlife (because of security fencing). The remaining land has been classified into four major vegetation zones, which are defined by the dominant plants present, and occur within specific elevational zones. These include mixed conifer forest, ponderosa pine forest, pinyon-juniper woodland, and juniper savannah (see **Figure 4–7**). The vegetative communities on and near LANL are very diverse, with over 900 species

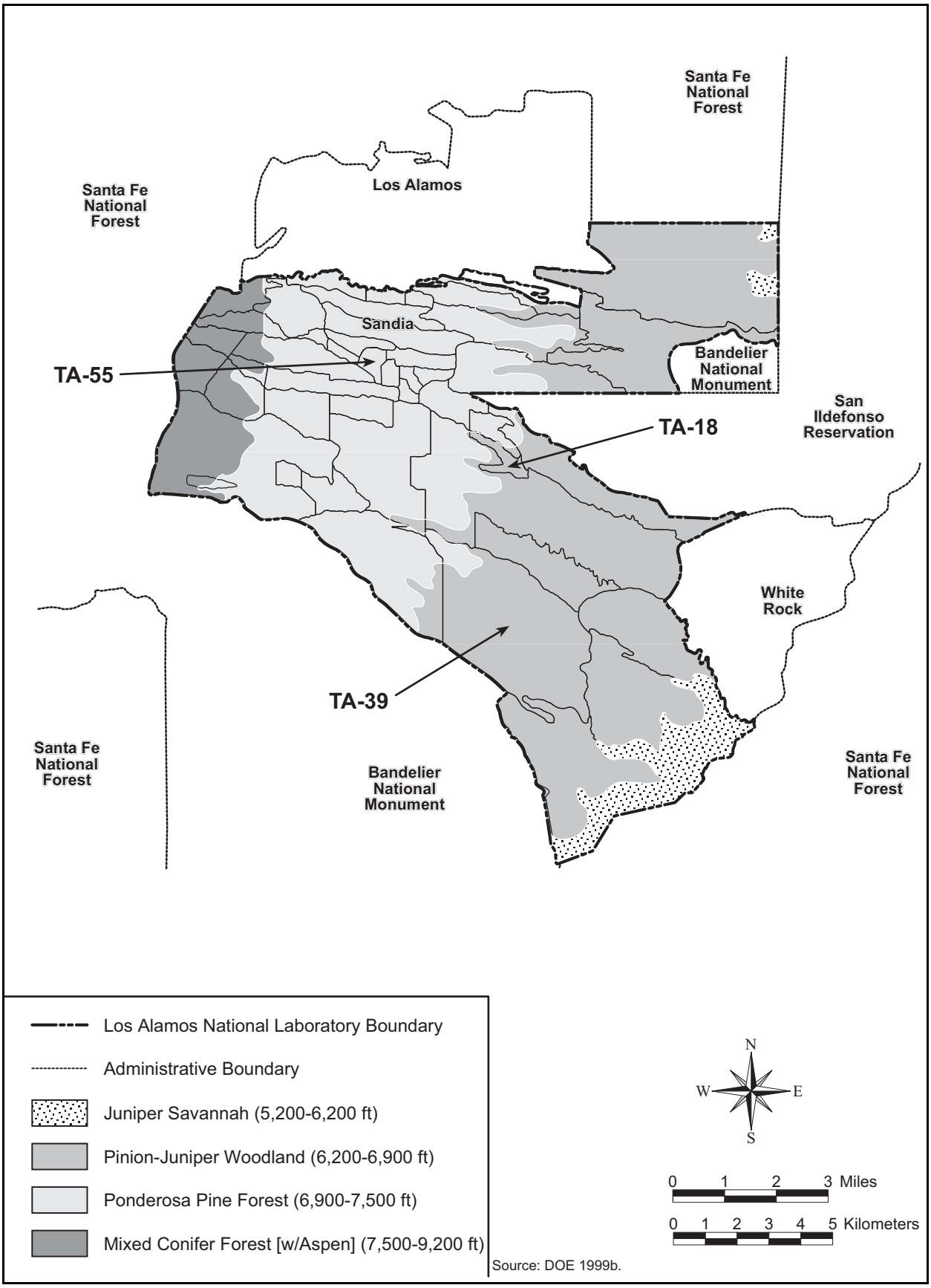


Figure 4–7 LANL Vegetation Zones

of vascular plants identified in the area. As noted in Section 4.2.1.1, the 405-hectare (1,000-acre) White Rock Canyon Wildlife Reserve, located in the southeast perimeter of LANL, was dedicated in 1999 because of its ecological and cultural resources and research potential (LANL 2000f).

Terrestrial animals associated with vegetation zones in the LANL area include 57 species of mammals, 200 species of birds, 28 species of reptiles, and 9 species of amphibians. Common animals found on LANL include the collared lizard, eastern fence lizard, black-headed grosbeak, western bluebird, elk, and raccoon (DOE 1996f). The most important and prevalent big game species at LANL are mule deer and elk. Elk populations have increased in the area from 86 introduced animals in 1948 and 1964 to an estimated population of over 10,000 animals. Hunting is not permitted on site. Numerous raptors, such as the red-tailed hawk and great-horned owl, and carnivores, such as the black bear and bobcat, are also found on LANL. A variety of migratory birds have been recorded at the site. Migratory birds are protected under the Migratory Bird Treaty Act.

The Cerro Grande Fire burned across 3,061 hectares (7,650 acres) of forest area within LANL. Additionally, fire suppression activities resulted in the clearing of 52 hectares (130 acres). Depending on fire intensity, existing vegetation either will be replaced by new species or will recover in a relatively short period. Where the fire intensity was high, it is likely that recolonization will be by other than the original species, with the possibility that exotic plants may gain a foothold in areas previously dominated by native species (DOE 2000g).

The Cerro Grande Fire dramatically altered the habitat of many animals. While initially eliminating or fragmenting the habitats of many animals (e.g., reptiles, amphibians, small mammals, and birds), with time the effects of the fire will also increase and improve the habitat for other species (e.g., large mammals) by creating more foraging areas. During the fire, individuals of many species died. Population recovery is expected within the next several breeding seasons. Elk and mule deer populations are expected to increase in the next several years in response to the additional foraging areas resulting from postfire vegetation regrowth (DOE 2000g).

Throughout LANL's history, developments within various TAs have caused significant alterations in the terrain and the general landscape of the Pajarito Plateau. These alterations have resulted in significant changes in land use by most groups of wildlife, particularly birds and larger mammals that have large seasonal and/or daily ranges. Certain projects required the segregation of large areas such as mesa tops and, in some cases, project areas were secured by fences around their perimeters. These alterations have undoubtedly caused some species of wildlife, such as elk and mule deer, to alter their land-use patterns by cutting off or changing seasonal or daily travel corridors to wintering areas, breeding habitats, foraging habitats, and bedding areas (DOE 1996f).

TA-18 is located in the pinyon-juniper woodland vegetation zone; however, approximately 20 percent of the site is developed. Animal species likely to be present in the area include the whiptail lizard, prairie lizard, canyon tree frog, scrub jay, house sparrow, cottontail rabbit, wood rat, and rock squirrel. Due to the presence of security fencing, no large animals would be found within developed portions of TA-18.

TA-55 is located in the ponderosa pine forest vegetation zone; however, forty-three percent of the site is developed. Animal species likely to be present in the area include the prairie lizard, white breasted nuthatch, Audubon's warbler, deer mouse, and raccoon. Due to the presence of security fencing, no large animals would be found within developed portions of TA-55.

4.2.7.2 Wetlands

A 1996 field survey identified an estimated 20 hectares (50 acres) of wetlands within LANL. The LANL survey determined that more than 95 percent of the identified wetlands are located in the Sandia, Mortandad, Pajarito, and Water Canyon watersheds.

Wetlands in the general LANL region provide habitat for reptiles, amphibians, and invertebrates (e.g., insects), and potentially contribute to the overall habitat requirements of a number of Federal- and state-listed species. The majority of the wetlands in the area are associated with canyon stream channels or are present on mountains or mesas as isolated meadows containing ponds or marshes, often in association with springs or seeps. There are also some springs bordering the Rio Grande within White Rock Canyon. Cochiti Lake, located downstream from LANL, supports lake-associated wetlands.

Currently, about 5 hectares (13 acres) of wetlands within LANL boundaries are caused or enhanced by process effluent wastewater from 21 NPDES-permitted outfalls. These artificially created wetlands are afforded the same legal protection as wetlands that stem from natural sources. In 1996, the effluent from NPDES outfalls, both storm water and process water, contributed 108 million gallons (407 million liters) to wetlands within LANL boundaries, and nearly half of the outfalls are probable sources of drinking water for large mammals.

During the Cerro Grande Fire, 6.5 hectares (16 acres), or 20 percent of the wetlands occurring on LANL, were burned at a low or moderate intensity. No wetlands within LANL were severely burned. Secondary effects from the fire to wetlands may also occur as a result of increased runoff due to the loss of vegetation. Wetlands were not disturbed by fire suppression activities; however, a number of projects were undertaken after the Cerro Grande Fire to control runoff and erosion. Two projects involving the enlargement of culverts in lower Pajarito Canyon, one about 0.4 kilometers (0.25 miles) downstream from TA-18 and the other at State Road 4, resulted in removal of about 0.6 hectares (1.5 acres) of wetland vegetation composed primarily of willow trees. Wetland vegetation is likely to regenerate over the next several years if the area is not silted in or scoured away by floodwaters (DOE 2000g).

There is one wetland located at the eastern end of TA-18. This wetland results from manmade sources and is characterized by riparian vegetation. Wetland plant species present include rush, willow, and broad-leafed cattail. Animals observed using this wetland include the many-lined skink, western chorus frog, red-winged blackbird, violet-green swallow, long-tailed vole, and vagrant shrew.

There are three wetlands located within TA-55. These wetlands result from natural sources and are characterized by vegetation and faunal components similar to those found in the wetland associated with TA-18.

4.2.7.3 Aquatic Resources

While the Rito de Los Frijoles in Bandelier National Monument (located to the south of LANL) and the Rio Grande are the only truly perennial streams in the region. Several of the canyon floors on LANL contain reaches of perennial surface water, such as the perennial streams draining lower Pajarito and Ancho Canyons to the Rio Grande. Surface water flow occurs in canyon bottoms seasonally, or intermittently, as a result of spring snowmelt and summer rain. A few short sections of riparian vegetation of cottonwood, willow, and other water-loving plants are present in scattered locations on LANL, as well as along the Rio Grande in White Rock Canyon. The springs and streams at LANL do not support fish populations; however, many other aquatic species thrive in these waters (DOE 1996f). Terrestrial wildlife use onsite streams for drinking and associated riparian habitat for nesting and feeding.

There are no aquatic resources located in either TA-18 or TA-55.

4.2.7.4 Threatened and Endangered Species

There are four agencies that have authority to designate threatened, endangered, and sensitive species in New Mexico. The agencies are the U.S. Fish and Wildlife Service (USFWS), the New Mexico Game and Fish Department, the New Mexico Forestry and Resource Conservation Division, and the U.S. Forest Service. The State of New Mexico separates the regulatory authority for plants and animals between the Forestry and Resource Conservation Division and the Game and Fish Department, respectively. The U.S. Forest Service lists species for special management consideration on lands under their jurisdiction and protects these species under the authority of the Endangered Species Act of 1973.

A number of regionally protected and sensitive (rare or declining) species have been documented in the LANL region (see **Table 4–7**). These consist of 2 federally endangered species (the whooping crane and southwestern willow flycatcher), 2 federally threatened species (the bald eagle and Mexican spotted owl), and 18 species of concern (species that may be of concern to USFWS but do not receive recognition under the Endangered Species Act, and that the USFWS encourages agencies to include in NEPA studies). Species listed as endangered threatened, rare, or sensitive by the State of New Mexico are also included in Table 4–7. The New Mexico "sensitive" taxa are those taxa that deserve special consideration in management and planning, and are not listed as threatened or endangered by the State of New Mexico. In addition, critical habitat for the threatened Mexican spotted owl has been designated on Santa Fe National Forest lands that are contiguous with LANL's western boundary.

As mentioned in Section 4.2.7.2, there is one wetland at TA-18. Threatened and endangered species and species of concern that are associated with this type of wetland and which may be found in the vicinity include the Northern goshawk which is listed as a species of concern, the federally threatened Mexican spotted owl, the state threatened spotted bat, the Federally endangered southwestern willow flycatcher, and the checkered lily, which is also listed as a species of concern.

There are three wetland locations within TA-55. These wetlands are similar in vegetation and components to the one at TA-18 and therefore the same threatened and endangered species and species of concern may be found in the vicinity of any of the wetlands within TA-55.

In addition, both TA-18 and TA-55 contain core and buffer Areas of Environmental Interest for the Mexican spotted owl. Areas of Environmental Interest are established under LANL's Habitat Management Plan (LANL 1998) and are areas within LANL that are being managed and protected because of their significance to biological or other resources. Habitats of threatened and endangered species that occur or may occur at LANL are designated as Areas of Environmental Interest. In general, an Area of Environmental Interest consists of a core area that contains important breeding or wintering habitat for a specific species and a buffer area around the core area. The buffer protects the area from disturbances that would degrade the value of the core area to the species.

The results of the Cerro Grande Fire likely will not cause a long-term change to the overall number of federally listed threatened and endangered species inhabiting the region. However, the results of the fire likely will change the distribution and movement of various species, including the Mexican spotted owl. The areas off LANL that have been proposed as critical habitat suffered heavy damage during the Cerro Grande Fire. Specifically, two primary areas considered as critical habitat for the Mexican spotted owl located on Forest Service land near LANL suffered almost 100 percent vegetation mortality. The fire may also have long-term effects on the habitat of several state-listed species, including the Jemez Mountain salamander. As noted in Section 4.2.7.2, two projects undertaken after the fire to enlarge culverts in the lower Pajarito

Canyon disturbed about 0.6 hectares (1.5 acres) of wetland vegetation composed primarily of willow trees. This wetland habitat was part of the habitat area used by the southwestern willow flycatcher at LANL, however, it was not a confirmed nesting habitat and was of marginal quality (DOE 2000g).

Table 4–7 Listed Threatened and Endangered Species, Species of Concern, and Other Unique Species That Occur or May Occur at LANL

Species	*Federal Classification*	*State Classification*	*Occurrence on LANL*
Mammals			
Big free-tailed bat	Special Concern	Special Concern	Migratory visitor
Fringed myotis	Special Concern	Special Concern	Observed on LANL, BNM, and SFNF lands
Goat peak pika	Special Concern	Special Concern	Observed on LAC and BNM lands
Long-eared myotis	Special Concern	Special Concern	Summer resident
Long-legged myotis	Special Concern	Special Concern	Summer resident
New Mexico jumping mouse	Special Concern	Threatened	Permanent resident on LAC and SFNF lands
Occult little brown bat	Special Concern	Special Concern	Observed on SFNF lands
Pale Townsend's big-eared bat	Special Concern	Special Concern	Observed on LANL and BNM lands
Small-footed myotis	Special Concern	Special Concern	Observed on LANL, BNM, and SFNF lands
Spotted bat	Special Concern	Threatened	Permanent resident on BNM and SFNF lands; Seasonal resident on LANL
Yuma myotis	Special Concern	Special Concern	Summer resident
Birds			
American peregrine falcon	Special Concern	Threatened	Forages on LANL
Baird's sparrow	Special Concern	Threatened	Observed on SFNF lands
Bald eagle	Threatened	Threatened	Winter visitor
Ferruginous hawk	Special Concern	Protected	Observed as a breeding resident
Gray vireo	Special Concern	Threatened	Observed on LAC, BNM, and SFNF lands
Loggerhead shrike	Special Concern	Special Concern	Observed on LAC, BNM, and SFNF lands
Mexican spotted owl	Threatened	Special Concern	Breeding resident on LANL, LAC, BNM, and SFNF lands; Critical habitat designated on SFNF lands
Northern goshawk	Special Concern	Special Concern	Observed as a breeding resident
Southwestern willow flycatcher	Endangered	Endangered	Potential presence on LANL and White Rock Canyon; Potential nesting area on LANL; Present in Jemez Mountains; Present in riparian zone near Española
White-faced ibis	Special Concern	Unlisted	Summer resident
Whooping crane	Endangered	Endangered	Migratory visitor along the Rio Grande and Cochiti Lake
Amphibians			
Jemez Mountain salamander	Special Concern	Threatened	Permanent resident
Fish			
Flathead chub	Special Concern	Unlisted	Permanent resident of the Rio Grande between Española and the Cochiti Reservoir
Plants			
Checkered lily	Unlisted	Special Concern	Observed on LAC, BNM, and SFNF lands
Helleborine orchid	Unlisted	Special Concern	Rare
Wood lily	Unlisted	Endangered	Observed on LAC, BNM, and SFNF lands
Yellow lady's slipper orchid	Unlisted	Endangered	Observed on BNM lands

LAC = Los Alamos County; BNM = Bandelier National Monument; SFNF = Sante Fe National Forest
Source: DOE 1999b.

4.2.8 Cultural and Paleontological Resources

4.2.8.1 Prehistoric Resources

Prehistoric resources at LANL refer to any material remains and items used or modified by people before the establishment of a European presence in the upper Rio Grande Valley in the early seventeenth century. Archaeological surveys have been conducted of approximately 75 percent of the land within LANL (with 60 percent of the area surveyed receiving 100 percent coverage) to identify the cultural resources present. The majority of these surveys emphasized prehistoric Native American cultural resources, including pueblos, rock shelters, rock art, water control features, trails, and game traps. A total of 1,295 prehistoric sites has been recorded on LANL, of which 1,192 have been assessed for potential nomination to the National Register of Historic Places. Of these, 770 sites were determined to be eligible, 322 sites potentially eligible, and 100 sites ineligible. The remaining 103 sites, which have not been assessed for nomination to the National Register of Historic Places, are assumed to be potentially eligible until assessed. Two areas in the vicinity of LANL have been established as National Register of Historic Places sites or districts: Bandelier National Monument (named as a monument in 1916) and Puye Cliffs Historical Ruins (DOE 1996f).

The Cerro Grande Fire affected 304 prehistoric sites; however, impacts to these sites are not fully known. Potential impacts could result from burned out tree root systems forming conduits for modern debris and water to mix with subsurface archaeological deposits and may provide an entry point for burrowing animals. Also, snags or dead or dying trees may fall and uproot artifacts (DOE 2000g). Areas at LANL burned by the Cerro Grande Fire will be surveyed for impacts over the next several field seasons.

TA-18 contains two prehistoric cultural resources. One site is comprised of approximately 40 prehistoric cavates (i.e., man-made rooms excavated in the tuff cliff faces of canyon walls). This complex of cavates was occupied discontinuously starting in the Coalition period and as late as the Post-Pueblo Revolt period. The second site is a rock shelter of undetermined Pueblo period age. Both sites have been determined eligible for the National Register of Historic Places by the New Mexico State Historic Preservation Office.

TA-55 contains one prehistoric lithic scatter that the New Mexico State Historic Preservation Office has determined is not eligible for the National Register of Historic Places.

4.2.8.2 Historic Resources

Historic resources present within LANL boundaries and on the Pajarito Plateau can be attributed to three phases: Spanish colonial, early U.S. territorial/statehood, and the nuclear energy period. Because of the very well-defined changes in the function of LANL, the nuclear energy period is further broken into three periods: World War II/early nuclear weapon development, early cold war, and late cold war. The numbers of artifacts or sites identified from each period are as follows: 0 from the Spanish colonial period, 87 from the early U.S. territorial/statehood period, 515 from World War II/early nuclear weapon development and early cold war periods, and 1,717 from the late cold war period; Thus, a total of 2,319 historic artifacts or sites has been identified at LANL. Of these, 214 have been recorded through site surveys. The remaining 2,105 resources were identified by reviewing the construction dates presented in a number of LANL documents and the site cultural resources database.

The Cerro Grande Fire affected 58 historic sites; some resources were severely impacted. Many wooden structures from the homestead era and from the Manhattan Project/cold war period and various Manhattan Project artifacts were adversely affected. The fire destroyed virtually all wooden buildings associated with the homestead era and sites were largely reduced to rubble. The V-site, which was among the last vestiges of the Manhattan Project at Los Alamos and the site where work was conducted on the Trinity device, was

partially destroyed. Building TA-16-516, the Trinity Assembly Building, survived the fire. The leveling of a staging area in TA-49 during the fire destroyed one and damaged two other cultural resource sites. Also, two historic structures at TA-2 were adversely impacted by postfire activities (DOE 2000g).

At TA-18 early U.S. territorial/statehood period sites include a mule train trail of undetermined National Register of Historic Places eligibility that was used to haul hay from the Valles Caldera to the Ashley Pond cabin. The Ashley Pond cabin is listed on the New Mexico State Register of Historic Places. TA-18 contains 50 buildings and structures dating to WWII through the early cold war periods. A historic building eligibility assessment of these buildings is currently underway. Extensive erosion and storm-water control efforts initiated after the Cerro Grande Fire will have beneficial effects on the historic Ashley Pond cabin. This structure has been surrounded by concrete barriers and sandbags to prevent damage from debris carried by storm-water runoff. Construction of a flood retention structure upstream will also provide the Ashley Pond cabin additional protection from flooding (DOE 2000g).

Historic resources at TA-55 include the early U.S. territorial/statehood period homestead site that is not eligible for the National Register of Historic Places. Also present is a National Register of Historic Places-eligible early U.S. territorial/statehood period structure.

4.2.8.3 Native American Resources

Consultations to identify traditional cultural properties were conducted with 19 Native American tribes in connection with the preparation of the *LANL SWEIS*. Two Hispanic communities were also contacted. These consultations identified 15 ceremonial and archaeological sites, 14 natural features, 10 ethnobotanical sites, 7 artisan material sites, and 8 subsistence features. In addition to physical cultural entities, concern has been expressed that "spiritual," "unseen," "undocumentable," or "beingness" aspects can be present at LANL that are an important part of Native American culture and may be adversely impacted by LANL's presence and operation. Additional consultations regarding traditional cultural properties are ongoing for LANL and other nearby DOE administered properties.

4.2.8.4 Paleontological Resources

No paleontological sites are reported to occur within LANL boundaries, and the near-surface stratigraphy is not conducive to preserving plant and animal remains. These near-surface materials are volcanic ash and pumice that were extremely hot when deposited.

4.2.9 Socioeconomics

Statistics for population, housing, community services, and local transportation are presented for the region of influence, a three-county area in New Mexico **(Figure 4–8)** in which 89.7 percent of all LANL employees reside (see **Table 4–8**).

4.2.9.1 Regional Economic Characteristics

Between 1990 and 1999, the civilian labor force in the Tri-County area increased 14.4 percent to the 1999 level of 92,189. In 1999, the annual unemployment average in the region of influence was 3.7 percent, which was less than the annual unemployment average of 5.6 percent for New Mexico (DOL 2000).

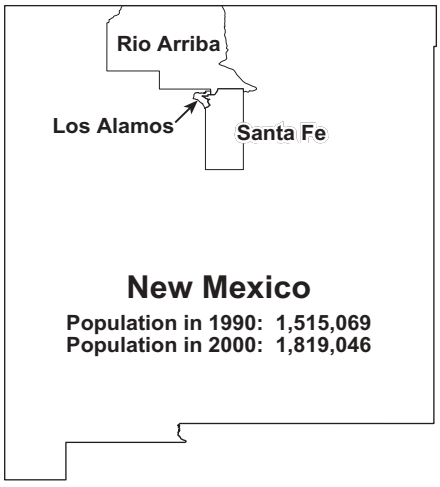


Figure 4–8 Counties in the LANL Region of Influence

In 1997, government agencies and enterprises represented the largest sector of employment in the Tri-County area (35.6 percent). This was followed by service activities (29.5 percent) and retail (20.7 percent). The totals for these employment sectors in New Mexico were 25.1 percent, 27.5 percent, and 23.7 percent, respectively (NMDL 1998).

Table 4–8 Distribution of Employees by Place of Residence in the LANL Region of Influence in 1996

County	*Number of Employees* [a]	*Total Site Employment (percent)*
Los Alamos	5,381	50.8
Rio Arriba	2,149	20.3
Santa Fe	1,967	18.6
Region of influence total	9,497	89.7

[a] Data not available for nontechnical contractors or consultants.
Source: DOE 1999b.

4.2.9.2 Demographic Characteristics

The 2000 demographic profile of the region of influence population and income information is included in **Table 4–9**. Persons self-designated as minority individuals comprise 57.9 percent of the total population. This minority population is composed largely of Hispanic or Latino and American Indian residents. The Pueblos of San Ildefonso, Santa Clara, San Juan, Nambe, Pojoaque, Tesques, and part of the Jicarilla Apache Indian Reservation are included in the region of influence.

Income information for the LANL region of influence is included in **Table 4–10**. There are significant differences in the income levels among the three counties, especially between Rio Arriba County, at the low end, and Los Alamos County, at the upper end. The median household income in Los Alamos County is over double that of the New Mexico state average while the median household income of Rio Arriba County is below the state average. In 1997, only 2.7 percent of the population in Los Alamos was below the official poverty level while in Rio Arriba County, 22.5 percent of the population was below the poverty level.

Table 4–9 Demographic Profile of the Population in the LANL Region of Influence

	Los Alamos	*Rio Arriba*	*Santa Fe*	*Region of Influence*
Population				
2000 population	18,343	41,190	129,292	188,825
1990 population	18,115	34,365	98,928	151,408
Percent change from 1990 to 2000	1.3	19.9	30.7	24.7
Race (2000) (percent of total population)				
White	90.3	56.6	73.5	71.5
Black or African American	0.4	0.3	0.6	0.5
American Indian and Alaska Native	0.6	13.9	3.1	5.2
Asian	3.8	0.1	0.9	1.0
Native Hawaiian & Other Pacific Islander	0.0	0.1	0.1	0.1
Some other race	2.7	25.6	17.7	18.0
Two or more races	2.3	3.3	4.1	3.7
Percent minority	17.9	86.4	54.5	57.9
Ethnicity (2000)				
Hispanic or Latino	2,155	30,025	63,405	95,585
Percent of total population	11.7	72.9	49.0	50.6

Source: DOC 2001.

Table 4–10 Income Information for the LANL Region of Influence

	Los Alamos	*Rio Arriba*	*Santa Fe*	*New Mexico*
Median household income 1997 ($)	74,253	25,036	37,882	30,836
Percent of persons below poverty line (1997)	2.7	22.5	11.9	19.3

Source: DOC 2000.

4.2.9.3 Housing and Community Services

Table 4–11 lists the total number of occupied housing units and vacancy rates in the region of influence. In 1990, the Tri-County area contained 63,386 housing units, of which 56,514 were occupied. The median value of owner-occupied units was $125,100 in Los Alamos County, which is higher than the other two counties and over twice the median value of units in Rio Arriba County. The vacancy rate was lowest in Los Alamos County (4.7 percent) and highest in Rio Arriba County (20.2 percent). During the Cerro Grande Fire, approximately 230 housing units were destroyed or damaged in northern portions of Los Alamos County (DOE 2000g). As a result, vacancy rates have decreased.

Community services include public education and healthcare (i.e., hospitals, hospital beds, and doctors). In 1998, student enrollment totaled 26,290 in the region of influence and the average student-to-teacher ratio was 17:1 (Department of Education 2000). In 1998, three hospitals served the Tri-County area with a hospital bed-to-population ratio of 1.9 hospital beds per 1,000 persons. The average region of influence's physician-to-population ratio was 2.7 physicians per 1,000 persons (Gaquin and DeBrandt 2000).

Table 4–11 Housing and Community Services in the LANL Region of Influence

	Los Alamos	*Rio Arriba*	*Santa Fe*	*Region of Influence*
Housing (1990) [a]				
Total units	7,565	14,357	41,464	63,386
Occupied housing units	7,213	11,461	37,840	56,514
Vacant units	352	2,896	3,624	6,872
Vacancy rate (percent)	4.7	20.2	8.7	10.8
Median value ($)	125,100	57,900	103,300	Not available
Public Education (1998) [b]				
Total enrollment	3,674	6,917	15,699	26,290
Student-to-teacher ratio	14.8:1	18:1	17.2:1	17:1
Community Healthcare (1998) [c]				
Hospitals	1	1	1	3
Hospital beds per 1,000 persons	2.9	2.1	1.7	1.9
Physicians per 1,000 persons	2.6	0.9	3.3	2.7

[a] DOE 1999b.
[b] Department of Education 2000.
[c] Gaquin and DeBrandt 2000.

4.2.9.4 Local Transportation

Motor vehicles are the primary means of transportation to LANL. Regional transportation route(s) connecting LANL to Albuquerque and Santa Fe are I–25 to U.S. 84/285 to NM 502; to Española are NM 30 to NM 502; and to Jemez Springs and western communities is NM 4. Hazardous and radioactive material shipments leave or enter LANL from East Jemez Road to NM 4 to NM 502 (see Figure 4–1). Only two major roads, NM 502 and NM 4, access Los Alamos County. Los Alamos County traffic volume on these two segments of highway is primarily associated with LANL activities.

A public bus service located in Los Alamos operates within Los Alamos County. The Los Alamos bus system consists of seven buses that operate five days a week. The nearest commercial bus terminal is located in Santa Fe. The nearest commercial rail connection is at Lamy, New Mexico, 83 kilometers (52 miles) southeast of LANL. LANL does not currently use rail for commercial shipments. The primary commercial international airport in New Mexico is located in Albuquerque. The small Los Alamos County Airport is owned by the Federal Government, and the operations and maintenance are performed by the County of Los Alamos. The airport is located parallel to East Road at the southern edge of the Los Alamos community. Until January 1996, the airport provided regular passenger and cargo service through specialized contract carriers such as Ross Aviation, which were under contract with DOE to provide passenger and cargo air service to Los Alamos County and LANL. DOE continues to negotiate with various companies to provide for service to the Los Alamos Airport.

4.2.10 Environmental Justice

Under Executive Order 12898, DOE is responsible for identifying and addressing disproportionately high and adverse impacts on minority or low-income populations. As discussed in Appendix E, minority persons are those who identify themselves as Hispanic or Latino, Asian, Black or African American, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, or multiracial. Persons whose income is below the Federal poverty threshold are designated as low-income.

There are three candidate locations at LANL for location of missions currently performed at TA-18. These are TA-18, TA-39, and TA-55. **Figure 4–9** shows candidate locations at LANL and regions of potential radiological impact. As shown in the figure, areas potentially at radiological risk from the current missions performed at TA-18 include the City of Santa Fe and Indian Reservations in North Central New Mexico. Eight counties are included or partially included in the potentially affected area (See **Figure 4–10**): Bernallilo, Los Alamos, Mora, Rio Arriba, Sandoval, San Miguel, Santa Fe, and Taos. **Table 4–12** provides the racial and Hispanic composition for these counties using data obtained from the decennial census conducted in 2000. In the year 2000, a majority of these county residents designated themselves as members of a minority. Hispanics and American Indians/Alaska Natives comprised over 90 percent of the minority population. As a percentage of the total resident population in 2000, New Mexico had the largest percentage minority population (55 percent) among the contiguous states and the second largest percentage minority population among all of the states (only Hawaii had a larger percentage minority population (77 percent)).

Figure 4–11 compares the growth in the minority populations in the potentially affected counties between 1990 and 2000. As discussed in Section E.5.1 of Appendix E, data concerning race and Hispanic origin from the 2000 Census cannot be directly compared with that for the 1990 Census because the racial categories used in the two enumerations were different. Bearing this change in mind, the minority population in potentially affected counties increased from approximately 49 percent to 54 percent in the decade from 1990 to 2000. Hispanics and American Indians/Alaska Natives accounted for over 80 percent of the increase in minority population during the decade. For comparison, minorities composed approximately one-quarter of the total population of the United States in 1990 and nearly one-third of the total population in 2000.

The percentage of low-income population at risk in potentially affected counties in 1990 was approximately 13 percent. In 1990, nearly 13 percent of the total population of the continental United States reported incomes less than the poverty threshold. In terms of percentages, minority populations at risk are relatively large in comparison with the national percentage, while the percentage low-income population at risk is commensurate with the corresponding national percentage. Complete census data with block group resolution for minority and low-income populations obtained from the decennial census of 2000 are scheduled for publication in 2002.

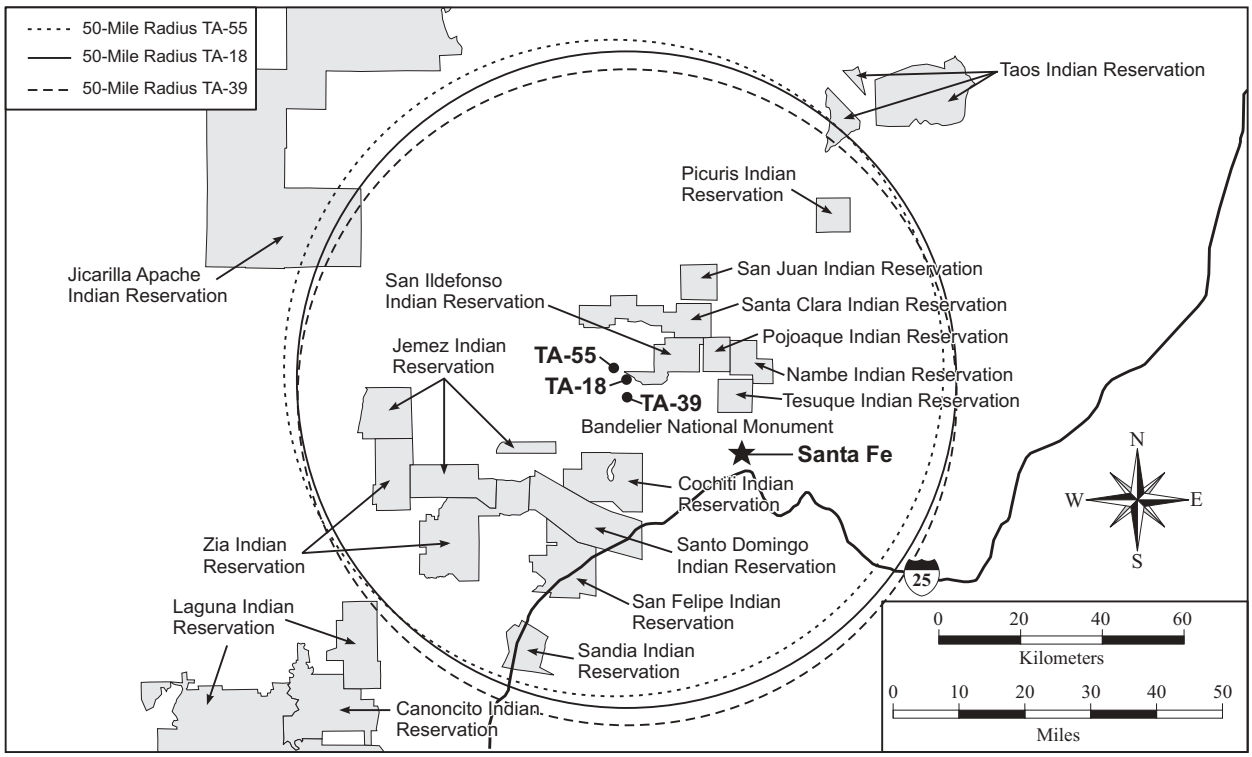


Figure 4–9 Candidate Locations and Indian Reservations Surrounding LANL

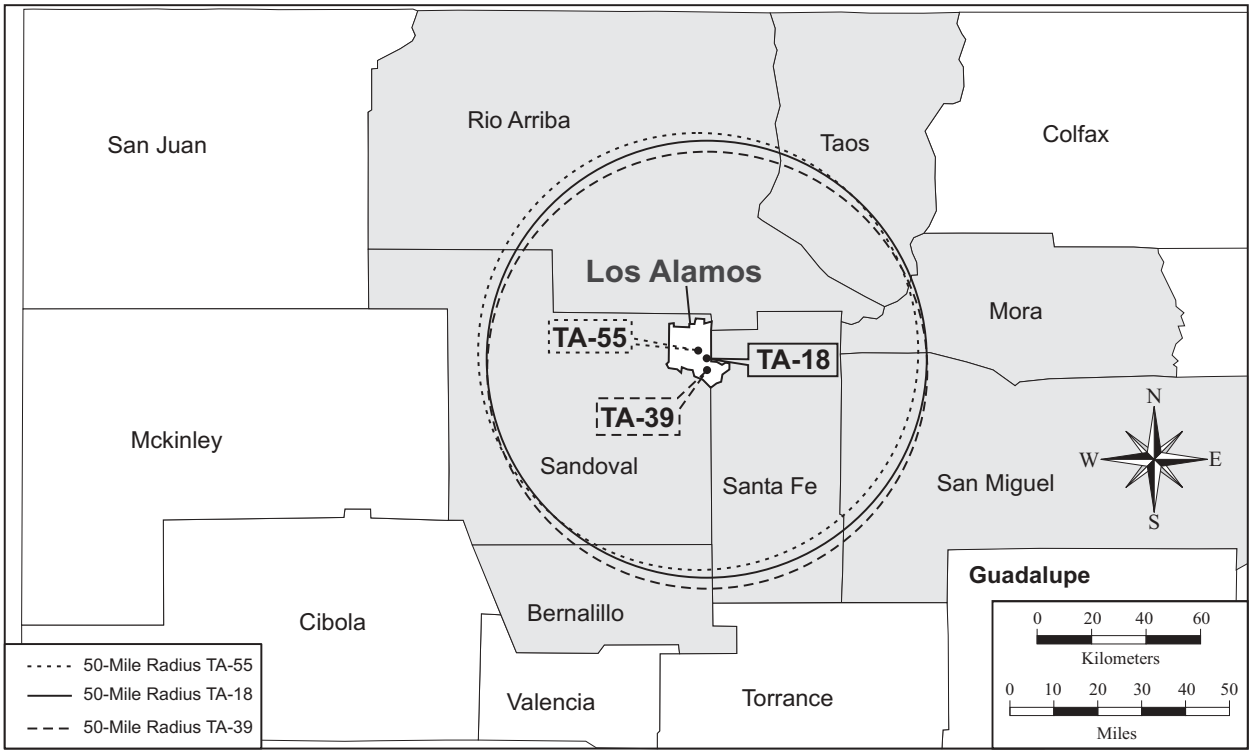


Figure 4–10 Potentially Affected Counties Surrounding LANL

Table 4–12 Populations in Potentially Affected Counties Surrounding LANL in 2000

Population Group	*Population*	*Percentage of Total*
Minority	488,850	54.3
Hispanic	400,673	44.5
Black/African American	16,204	1.8
American Indian/Alaska Native	44,430	4.9
Asian	13,195	1.5
Native Hawaiian/Pacific Islander	607	0.1
Two or more races	13,741	1.5
Some other race	1,498	0.2
White	410,348	45.6
Total	900,696	100.0

Source: DOC 2001.

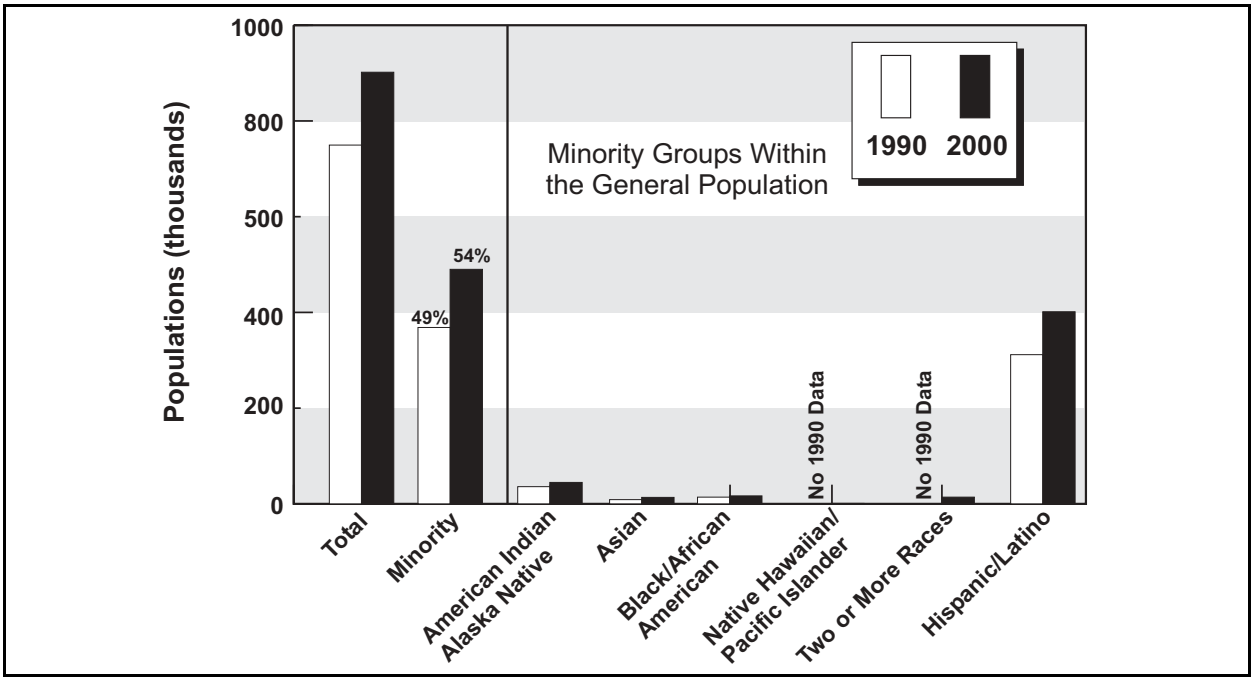


Figure 4–11 Comparison of Populations in Potentially Affected Counties Surrounding LANL in 1990 and 2000

4.2.11 Existing Human Health Risk

Public and occupational health and safety issues include the determination of potentially adverse effects on human health that result from acute and chronic exposure to ionizing radiation and hazardous chemicals.

4.2.11.1 Radiation Exposure and Risk

Major sources and levels of background radiation exposure to individuals in the vicinity of LANL are shown in **Table 4–13**. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses are unrelated to LANL operations.

Table 4–13 Sources of Radiation Exposure to Individuals in the LANL Vicinity Unrelated to LANL Operations

Source	*Effective Dose Equivalent (millirem per year)*
Natural Background Radiation	
Total external (cosmic and terrestrial) [a]	120
Internal terrestrial and global cosmogenic [b]	40
Radon in homes (inhaled)	200 [b, c]
Other Background Radiation [b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	less than 1
Air travel	1
Consumer and industrial products	10
Total	425

[a] LANL 2000f.
[b] NCRP 1987.
[c] An average for the United States.

Releases of radionuclides to the environment from LANL operations provide another source of radiation exposure to individuals in the vicinity of LANL. Types and quantities of radionuclides released from LANL operations in 1999 are listed in *Environmental Surveillance at Los Alamos During 1999* (LANL 2000f). The releases are summarized in Sections 4.2.3.2 and 4.2.6.1 of this EIS. The doses to the public resulting from these releases are presented in **Table 4–14**. These doses fall within the radiological limits given in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, and are much lower than those from background radiation.

Table 4–14 Radiation Doses to the Public from Normal LANL Operations in 1999 (total effective dose equivalent)

	Atmospheric Releases		*Liquid Releases*		*Total*	
Members of the Public	*Standard* [a]	*Actual*	*Standard* [a]	*Actual*	*Standard* [a]	*Actual*
Maximally exposed offsite individual (millirem)	10	0.40	4	0.25	100	0.65
Population within 80 kilometers (50 miles) (person-rem) [b]	None	0.30	None	~0	100	0.30
Average individual within 80 kilometers (50 miles) (millirem) [c]	None	0.0011	None	~0	None	0.0011

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10-millirem-per-year limit from airborne emissions is required by the Clean Air Act (40 CFR 61) and the 4-millirem-per-year limit is required by the Safe Drinking Water Act (40 CFR 141). For this EIS, the 4-millirem-per-year value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100 millirem per year is the limit from all pathways combined. The 100-person-rem value for the population is given in proposed 10 CFR 834, *Radiation Protection of the Public and the Environment: Proposed Rule*, as published in 58 FR 16268. If the potential total dose exceeds the 100-person-rem value, the contractor operating the facility would be required to notify DOE.
[b] About 264,000 based on county population estimates for 1999.
[c] Obtained by dividing the population dose by the number of people living within 80 kilometers (50 miles) of the site.
Note: About 80 percent of the dose to the maximally exposed onsite individual was attributable to TA-18 operations. The fractional dose contribution to offsite receptors from TA-18 operations is very small.
Source: LANL 2000f.

Using a risk estimator of one latent cancer death per 2,000 person-rem to the public (see Appendix B), the fatal cancer risk to the maximally exposed offsite member of the public due to radiological releases from LANL operations is estimated to be 3.3×10^{-7}. The estimated probability of this maximally exposed person

dying of cancer at some point in the future from radiation exposure associated with one year of LANL operations is less than one in one million (it takes several to many years from the time of radiation exposure for a cancer to manifest itself).

According to the same risk estimator, 1.5×10^{-4} excess fatal cancers are projected in the population living within 80 kilometers (50 miles) of LANL from normal LANL operations. To place this number in perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The mortality rate associated with cancer for the entire U.S. population is 0.2 percent per year. Based on this mortality rate, the number of fatal cancers expected during 1999 from all causes in the population of 264,000 living within 80 kilometers (50 miles) of LANL was 528. This expected number of fatal cancers is much higher than the 1.5×10^{-4} fatal cancers estimated from LANL operations in 1999.

Members of the public passing by the TA-18 facility along Pajarito Road could receive an external radiation dose from critical assembly operations at TA-18. Based on radiation doses that have been measured along Pajarito Road, the road is closed to the public for any operation that would result in more than 4.75 millirem in any hour along the road. As a result, the maximum dose that a member of the public would receive from a single operation at TA-18 would be 4.75 millirem (LANL 2001a).

A conservative estimate of the average number of times each year that an individual could be in a position to be exposed to this radiation level (based on 10 trips along Pajarito Road each day) is less than one (LANL 2001a). Therefore, the expected dose from direct radiation to the maximally exposed individual traveling on Pajarito Road is less than 4.75 millirem, and the risk of a latent fatal cancer from this dose is less than 2.4×10^{-6} per year.

LANL workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. The average dose to the individual worker and the cumulative dose to all workers at LANL from operations in 1998 are presented in **Table 4–15**. These doses fall within the radiological regulatory limits of 10 CFR 835. According to a risk estimator of one latent fatal cancer per 2,500 person-rem among workers (see Appendix B), the number of projected fatal cancers among LANL workers from normal operations in 1998 is 0.065. The risk estimator for workers is lower than the estimator for the public because of the absence from the workforce of the more radiosensitive infant and child age groups.

Table 4–15 Radiation Doses to Workers from Normal LANL Operations in 1998 (total effective dose equivalent)

Occupational Personnel	*Onsite Releases and Direct Radiation*	
	Standard [a]	***Actual***
Average radiation worker (millirem)	None [b]	85
Total workers [c] (person-rem)	None	162

[a] The radiological limit for an individual worker is 5,000 millirem per year (10 CFR 835). However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. Therefore, DOE has recommended an administrative control level of 500 millirem per year (DOE 1999c); the site must make reasonable attempts to maintain individual worker doses below this level.

[b] No standard is specified for an average radiation worker; however, the maximum dose that this worker may receive is limited to that given in footnote [a].

[c] There were 1,916 workers with measurable doses in 1998.

Source: DOE 1998b.

External radiation doses have been measured in areas of TA-18 and TA-55 that may contain radiological sources for comparison with offsite natural background radiation levels. Measurements taken in 1999 showed average doses within TA-18 and TA-55 of 189 millirem and 157 millirem, respectively, compared to an average offsite dose of 126 millirem (LANL 2000f).

In 1999, the average concentration in air of plutonium-239, gross alpha, and gross beta radiation on the LANL site were measured to be 1.5×10^{-18} curies per cubic meter, 9.4×10^{-16} curies per cubic meter, and 1.3×10^{-14} curies per cubic meter, respectively. The value of plutonium-239 does not include a relatively high "hot spot" in TA-54. The concentration of plutonium-239 was about twice that measured at offsite regional locations; the concentrations of gross alpha and beta radiation were about the same as measured regionally (LANL 2000f). No specific measurements were reported for TA-18 or TA-55, but the concentrations would be expected to be similar to the average site values.

4.2.11.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., soil through direct contact or via the food pathway).

Adverse health impacts to the public are minimized through administrative and design controls to decrease hazardous chemical releases to the environment and to achieve compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at LANL via inhalation of air containing hazardous chemicals released to the atmosphere by LANL operations. Risks to public health from ingestion of contaminated drinking water or direct exposure are also potential pathways.

Baseline air emission concentrations for air pollutants and their applicable standards are presented in Section 4.2.3.1. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are compared with applicable guidelines and regulations.

Chemical exposure pathways to LANL workers during normal operations may include inhaling the workplace atmosphere, drinking LANL potable water, and possible other contact with hazardous materials associated with work assignments. Workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. LANL workers are also protected by adherence to the Occupational Safety and Health Administration (OSHA) and EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals used in the operation processes, ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at LANL are substantially better than required by standards.

4.2.11.3 Health Effects Studies

Numerous epidemiological studies have been conducted in the LANL area. These studies have been summarized in the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management (SSM PEIS)* (DOE 1996e). One study conducted by the New Mexico Department of Health reported elevations in brain cancer incidence during the mid to late 1980s, compared to state and national reference populations, but random fluctuation could not be ruled out. Breast cancer incidence rates in Los Alamos from 1970 to 1990 remained level, but higher than New Mexico rates. Reproductive and demographic factors known to increase the risk of breast cancer have been prevalent in the county. Ovarian cancer incidence in the county from 1986 to 1990 was approximately twofold greater than that observed in a New Mexico State reference population. In the mid to late-1980s, a twofold excess risk of melanoma was

observed in Los Alamos County compared with a New Mexico State reference population. A more recent study observed a fourfold increase in thyroid cancer incidence during the late 1980s and early 1990s compared with the state as a whole, but the rate began to decline in 1994 and 1995. No statistically significant excess cancers were reported for male workers exposed to plutonium. However, statistically significant excesses in kidney cancer and lymphomatic leukemia were observed in male workers exposed to external radiation. For more detailed descriptions of studies reviewed and the findings, refer to Appendix Section D.1.2 of the *LANL SWEIS* and to Appendix Section E.4.6 of the *SSM PEIS* (DOE 1996e).

4.2.11.4 Accident History

Although LANL experienced a number of criticality accidents in the period of 1945 to the early 1980s, a review of more recent LANL annual environmental and accident reports indicates that there have been no accidents since that time that have resulted in significant adverse impacts to workers, the public, or the environment (DOE 1996f). During the review period, from 1986 to 1990, site operations were much higher than in previous years and also higher than what is anticipated for the future (DOE 1996f).

Since 1945, there have been 13 criticality accidents at LANL (LANL 2000h). The accidents occurred during processing, critical experiment setups, and operations. These accidents resulted in various levels of radiation exposure to involved workers and in no or small damage to the equipment. The early criticality accidents (up to 1946) resulted in worker fatalities. After 1947, the laboratory constructed remote criticality experiment facilities, leading to minimum doses to workers from criticality accidents. None of the accidents resulted in any significant exposure to members of the public.

On May 4, 2000, the National Park Service at Bandelier National Monument set a prescribed fire that subsequently burned out of control. This Cerro Grande Fire damaged or destroyed 112 LANL structures and about 230 residential structures in the Los Alamos town site. By the time it was contained, it had burned 3,061 hectares (7,650 acres) within the boundaries of LANL. LANL is conducting an extensive environmental monitoring and sampling program to evaluate the effects of that fire at the laboratory and especially to evaluate if public and worker health and the environment were adversely impacted by the fire on laboratory land. The program will identify changes from prefire baseline conditions that will aid in evaluating potential future impacts, especially those from any contaminants that may have been transported off site (LANL 2000f).

4.2.11.5 Emergency Preparedness

Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes emergency planning, training, preparedness, and response. The emergency management program was activated on May 5, 2000 to coordinate emergency management operations during the Cerro Grande Fire.

DOE maintains equipment and procedures to respond to situations where human health or the environment is threatened. These include specialized training and equipment for the local fire department, local hospitals, state public safety organizations, and other government entities that may participate in response actions, as well as specialized assistance teams (DOE Order 151.1, *Comprehensive Emergency Management System*). These programs also provide for notification of local governments whose constituencies may be threatened. Broad ranges of exercises are run to ensure the systems are working properly, from facility-specific exercises to regional responses. In addition, DOE has specified actions to be taken at all DOE sites to implement lessons learned from the emergency responses to an accidental explosion at Hanford in May 1997.

4.2.12 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. The waste is managed using appropriate treatment, storage, and disposal technologies, and in compliance with all applicable Federal and state statutes and DOE orders.

4.2.12.1 Waste Inventories and Activities

LANL manages the following types of waste: transuranic, mixed transuranic, low-level radioactive, mixed low-level radioactive, hazardous, and nonhazardous. Because there is no transuranic or mixed transuranic waste associated with TA-18 operations, these waste types are not discussed in this EIS. Waste generation rates and the inventory of stored waste from activities at LANL are provided in **Table 4–16**. Selected waste management facilities at LANL are summarized in **Table 4–17**.

Table 4–16 Selected Waste Generation Rates and Inventories at LANL

Waste Type	*Generation Rate (cubic meters per year)*	*Inventory (cubic meters)*
Low-level radioactive	2,840 [a]	Not available
Mixed low-level radioactive	98 [a]	759 [a]
Hazardous (in kilograms)	860,600 [a,b]	Not applicable [c]
Nonhazardous		
Liquid	692,857 [d]	Not applicable [c]
Solid	5,453 [d]	Not applicable [c]

[a] DOE 1999b.
[b] This waste type also includes biomedical waste.
[c] Generally, hazardous and nonhazardous waste are not held in long-term storage.
[d] DOE 1999g.
Note: The generation rates are attributed to facility operations and do not include the waste generated from environmental restoration actions.

Table 4–17 Selected Waste Management Facilities at LANL

Facility Name/Description	*Capacity*	*Status*	*Applicable Waste Type*			
			Low-Level Radioactive Waste	*Mixed Low-Level Radioactive Waste*	*Hazardous*	*Non-hazardous*
Treatment Facility (cubic meters per year)						
Low-level radioactive waste compaction	76	Online	X			
Sanitary wastewater treatment	1,060,063	Online				X
Storage Facility (cubic meters)						
Low-level radioactive waste storage	663	Online	X			
Mixed low-level radioactive waste storage	583	Online		X		
Hazardous waste storage	1,864	Online			X	
Disposal Facility						
TA-54, Area G low-level radioactive waste disposal (cubic meters)	252,500 [a]	Online	X			
Sanitary tile fields (cubic meters per year)	567,750	Online				X

[a] Current inventory of 250,000 cubic meters. Capacity will be expanded as part of implementation of the *LANL SWEIS* Record of Decision.
Source: DOE 1999g.

Although not listed on the National Priorities List, LANL adheres to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidelines for environmental restoration projects that involve certain hazardous substances not covered by the Resource Conservation and Recovery Act (RCRA). LANL's environmental restoration program originally consisted of approximately 2,100 potential release sites (DOE 1999g). At the end of 1999, there remained 1,206 potential release sites requiring investigation or remediation and 118 buildings awaiting decontamination and decommissioning. Potential release sites at TA-18 have been investigated and characterized. Most of the potential release sites have been recommended for no further action, following site characterization. Several potential release sites at TA-18 have undergone either interim or final remediation to remove contaminants and decrease the potential for future releases and migration off site. Based on a review by LANL's Environmental Restoration Project, the boundary of Potential Release Site 48-001 overlaps a small area in the corner of the proposed relocation site at TA-55. This area of overlap involves possible surface soil contamination from TA-48 stack emissions. Further investigation and any necessary remediation of this site will be completed under LANL's environmental restoration program (LANL 2001b) and in accordance with LANL's Hazardous Waste Facility Permit. More information on regulatory requirements for waste disposal is provided in Chapter 6.

4.2.12.2 Low-Level Radioactive Waste

Solid low-level radioactive waste generated by LANL's operating divisions is characterized and packaged for disposal at the onsite low-level radioactive waste disposal facility at TA-54, Area G. Low-level radioactive waste minimization strategies are intended to reduce the environmental impact associated with low-level radioactive waste operations and waste disposal by reducing the amount of low-level radioactive waste generated and/or minimizing the volume of low-level radioactive waste that will require storage or disposal onsite (LANL 2000a).

A 1998 analysis of the low-level radioactive waste landfill at TA-54, Area G, indicated that at previously planned rates of disposal, the disposal capacity would be exhausted in a few years. Reduction in low-level radioactive waste generation has extended this time to approximately five years; however, potentially large volumes of waste from planned construction upgrades could rapidly fill the remaining capacity (LANL 2000a).

As part of the implementation of the Record of Decision in the *LANL SWEIS*, DOE will continue onsite disposal of LANL-generated low-level radioactive waste using the existing footprint at the Area G low-level waste disposal area and will expand disposal capacity into Zones 4 and 6 at Area G. This expansion would cover up to 29 hectares (72 acres). Additional sites for low-level radioactive waste disposal at Area G would provide onsite disposal for an additional 50 to 100 years (64 FR 50797, LANL 2000a).

Liquid low-level radioactive waste is transferred through a system of pipes and by tanker trucks to the Radioactive Liquid Waste Treatment Facility at TA-50, Building 1. The radioactive components are removed and disposed of as solid low-level radioactive waste at TA-54, Area G. The remaining liquid is discharged to a permitted outfall (LANL 2000a).

4.2.12.3 Mixed Low-Level Radioactive Waste

There are seven major mixed low-level radioactive waste streams at LANL: circuit boards, gloveboxes, lead parts, research and development chemicals, personal protective equipment, fluorescent tubes, and waste generated from spills and spill cleanup. Typically, mixed low-level radioactive waste is transferred to a satellite storage area once generated. Whenever possible, mixed low-level materials are surveyed to confirm the radiological contamination levels, and if decontamination will eliminate either the radiological or the

hazardous component, materials are decontaminated and removed from the mixed low-level radioactive waste category (LANL 2000a).

Proper waste management and Department of Transportation documentation are provided for solid waste operations at TA-54, Area G or Area L, to process remaining mixed low-level radioactive waste for storage, bulking, and transportation. From TA-54, mixed low-level radioactive waste is sent to commercial and DOE treatment and disposal facilities. The waste is treated/disposed of by various processes (e.g., segregation of hazardous components, macroencapsulation, or incineration) (LANL 2000a).

In October 1995, the State of New Mexico issued a Federal Facility Compliance Order to both DOE and LANL requiring compliance with the site treatment plan. That plan documents the development of treatment capacities and technologies or use of offsite facilities for treating mixed waste generated at LANL that is stored beyond the one-year time frame (LANL 2000f).

4.2.12.4 Hazardous Waste

Most LANL activities generate some amount of hazardous waste. Hazardous waste commonly generated at LANL includes many types of laboratory research chemicals, solvents, acids, bases, carcinogens, compressed gases, metals, and other solid waste contaminated with hazardous waste. This may include equipment, containers, structures, and other items intended for disposal and contaminated with hazardous waste (e.g., compressed gas cylinders). After the hazardous waste is collected, it is sorted and segregated. Some materials are reused within LANL, and others are decontaminated for reuse. Those materials that cannot be decontaminated or recycled are packaged and shipped to offsite RCRA-permitted treatment and disposal facilities (LANL 2000a).

4.2.12.5 Nonhazardous Waste

Both LANL and Los Alamos County use the same landfill located within LANL boundaries. The landfill is operated under a special permit by Los Alamos County. The Los Alamos County Landfill received about 20 million kilograms (22,013 tons) of solid waste from all sources during the period of July 1995 through June 1996, with LANL contributing about 22 percent of the solid waste. Since the Cerro Grande Fire, the generation of wastes from community and LANL cleanup activities have increased several fold. The Los Alamos County landfill is scheduled for closure on June 30, 2004. A replacement facility, which would be located offsite, would then be used by LANL for nonhazardous waste disposal. It is currently anticipated that the replacement facility would be located within 160 kilometers (100 miles) of LANL. Both LANL and Los Alamos County would need to transport their wastes to the new facility.

Sanitary liquid waste is delivered by dedicated pipelines to the Sanitary Wastewater Systems Consolidation Plant at TA-46. The plant has a design capacity of 2.27 million liters (600,000 gallons) per day, and in 2000 processed a maximum of about 950,000 liters (250,000 gallons) per day. Some septic tank pumpings are delivered periodically to the plant for treatment via tanker truck. Sanitary waste is treated by an aerobic digestion process. After treatment, the liquid from this process is recycled to the TA-3 power plant for use in cooling towers or is discharged to Sandia Canyon adjacent to the power plant under an NPDES permit and groundwater discharge plan. Under normal operating conditions, the solids from this process are dried in beds at the Sanitary Wastewater Systems Consolidation Plant and are applied as fertilizer as authorized by the existing NPDES permit.

4.2.12.6 Waste Minimization

LANL's Environmental Stewardship Office manages LANL's pollution prevention program. This is accomplished by eliminating waste through source reduction or material substitution; by recycling potential waste materials that cannot be minimized or eliminated; and by treating all waste that is generated to reduce its volume, toxicity, or mobility prior to storage or disposal. The achievements and progress have been updated at least annually. Implementing pollution prevention projects reduced the total amount of waste generated at LANL in 1999 by approximately 2,459 cubic meters (3,216 cubic yards). Examples of pollution prevention projects completed in 1999 at LANL include reduction of low-level radioactive waste and mixed low-level radioactive waste by 116 cubic meters (152 cubic yards) by decontaminating waste metal and reduction of transuranic waste by 3 cubic meters (4 cubic yards) by using improved nondestructive assay instrumentation, which enabled the measurement and characterization of waste as either transuranic or low-level radioactive waste (DOE 2000h).

4.2.12.7 Waste Management PEIS Records of Decision

The *Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (*Waste Management PEIS*) Records of Decision affecting LANL are shown in **Table 4–18**. Decisions on the various waste types were announced in a series of Records of Decision that have been published on the *Waste Management PEIS* (DOE 1997a). The hazardous waste Record of Decision was published on August 5, 1998 (63 FR 41810), and the low-level radioactive and mixed low-level radioactive waste Record of Decision was published on February 18, 2000 (65 FR 10061). The hazardous waste Record of Decision states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with the Oak Ridge Reservation and the Savannah River Site continuing to treat some of their own nonwastewater hazardous waste on site in existing facilities, where this is economically feasible. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision states that, for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue, to the extent practicable, on site at INEEL, LANL, the Oak Ridge Reservation, and the Savannah River Site. In addition, Hanford and NTS will be available to all DOE sites for low-level radioactive waste disposal. Mixed low-level radioactive waste will be treated at Hanford, INEEL, the Oak Ridge Reservation, and the Savannah River Site and disposed of at Hanford and NTS. More detailed information concerning DOE's decisions for the future configuration of waste management facilities at LANL is presented in the hazardous waste and the low-level radioactive and mixed low-level radioactive waste Records of Decision.

Table 4–18 Waste Management PEIS Records of Decision Affecting LANL

Waste Type	*Preferred Action*
Low-level radioactive	DOE has decided to treat LANL's low-level radioactive waste on site and continue onsite disposal. [a]
Mixed low-level radioactive	DOE has decided to regionalize treatment of mixed low-level radioactive waste at the Hanford Site, INEEL, the Oak Ridge Reservation, and the Savannah River Site. DOE has decided to ship LANL's mixed low-level radioactive waste to either the Hanford Site or NTS for disposal. [a]
Hazardous	DOE has decided to continue to use commercial facilities for treatment of most of LANL's nonwastewater hazardous waste. [b]

[a] From the Record of Decision for low-level radioactive and mixed low-level radioactive waste (65 FR 10061).
[b] From the Record of Decision for hazardous waste (63 FR 41810).
Source: 65 FR 10061, 63 FR 41810.